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Permanent Secretary Denison Scientific Association

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## **HIEROSAURUS COLEII: A NEW AQUATIC DINOSAUR FROM THE NIOBRARA CRETACEOUS OF KANSAS**

M. G. MEHL

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So seldom have dinosaur bones been found in marine formations that records of such occurrences, no matter how scanty, are of interest entirely out of proportion to their morphological value. Wieland has stressed the rarity and importance of such finds in his notes on "A Pierre Dinosaur" (8). In addition to their interest as marine occurrences a few finds have added to the obscure record of an aberrant branch of the armored dinosaurs, the status of which is still in doubt.

So far as the writer can learn, only three occurrences of dinosaurs in the Niobrara, all from western Kansas, have been recorded. The first of these was found by Marsh on the Smoky Hill River in 1872 and described by him under the name *Hadrosaurus agilis* (4). The remains are insufficient to make certain the generic identity and they were later referred to either *Thespesius* or *Claosaurus* (3).

A second find, at the time suggesting little more than possible dinosaur remains, was figured by Wieland (6) in connection with the third find, *Hierosaurus Sternbergii*, (6) which was described as consisting of six dermal scutes. A previous notice by Sternberg (5), apparently of the specimen described by Wieland, leads one to believe that the material included a considerable part of the skeleton. Further investigation at the type locality added to the original material (7).

In the spring of 1930, Virgil B. Cole sent to the University of Missouri several specimens of vertebrates from the Niobrara of western Kansas. One large collection of bone fragments proved to be representative parts of a remarkable armored dinosaur of moderate size. Not only is this specimen much more nearly

complete than any of the other representatives of the little known group of highly modified stegosaurids, but it gives evidence that there was a definite aquatic trend in the group and possibly a complete marine adaptation in this form.

The material includes parts of the skull that give some information concerning the dentition; dorsal, sacral, and caudal vertebrae; ribs and chevrons; part of a scapula and a considerable part of the pelvis; one complete hind leg and parts of the other; one complete humerus with well preserved radius and ulna and parts of the corresponding bones of the opposite side; and a large number of dermal scutes of various sizes and shapes. Most of the skeleton was weathered and broken into many pieces, but some of the vertebrae and the limbs of the right side were well preserved in the chalk matrix. Many of the scattered fragments were readily reassembled into complete bones. This fact and a knowledge of the care with which Mr. Cole does his collecting leads the writer to believe that missing parts of the skeleton were scattered before burial. This material is described in detail in the following pages.

#### *Hierosaurus coleii*, new species

*Type*.—Specimen No. 650 V.P., U. of Mo., representative parts from most of the skeleton and dermal armor.

*Locality*.—Gove County, Kansas (Sec. 16, Twp. 15 S., R. 26 W.), about 11 miles south and a little east of Hackberry.

*Geological occurrence*.—Niobrara formation, 195 feet above base, in the "Smoky Hill Chalk" member.

*Hierosaurus coleii* is a flat bodied dinosaur with total length, including a moderately long slender tail, of about fifteen feet.

#### THE SKULL

The skull was flattened and crushed sidewise by the compaction of the inclosing sediments so that the palate features have lost their normal relationship with the dorso-median line. Small fragments represent a considerable area of the skull, but only one large section of the right half from about mid-length furnishes data of value.

The dermal scutes, as in *Palaeoscincus* (2), consist of a few comparatively large plates closely united with the skull. Their surface is fairly smooth except for widely spaced minute pores. These scutes are separated from each other by well marked sulci. They average about 5 mm. in thickness.

The specimen indicates a skull highly arched both transversely and antero-posteriorly. In length it probably agreed closely with the type of *Palaeoscincus rugosidens* (2), but seems to be much narrower in the region of the orbit.

#### THE DENTITION

On the badly crushed left maxilla eight alveolae are preserved in a length of 58 mm. Five are preserved on the right maxilla. The left series apparently represents the anterior eight, but of this there is no assurance. Although the root of a tooth is preserved in each of these only one, the posterior of the left series, shows some of the details of the crown. These correspond well with the features of a well preserved tooth of an isolated alveolar margin, possibly from the mandible, and it is the latter from which the accompanying description and figure are taken.

The root of the single well-preserved tooth is slightly compressed laterally with diameters of 3.7 mm. and 3.2 mm. The average root diameter for the entire series is near 4.5 mm. The root of the figured specimens is 7 mm. long, but others may be as much as 12 mm. It is constricted immediately below the crown, a condition much accentuated by the marked antero-postero expansion of the crown at its base and a considerably less lateral expansion.

The crown is short and spatulate with a nearly flat inner face. The outer face is convex in cross section at its base and slopes in straight lines from this outline to the cutting edge. It is set off from the cingulum more sharply on the outer than on the inner side. The cutting edge consists of a large median apical denticle and four slightly smaller, but sharply set off denticles on both the anterior and posterior edges. On each edge the first or basal denticle is in reality an extension of the cingulum rather than of the spatulate crown. The antero-posterior and lateral measure-

ments at the base are 6 mm. and 3.3 mm., respectively. The height of the crown, measured from the upper neck-like constriction of the root, is 6 mm.

#### THE VERTEBRAL COLUMN AND RIBS

The entire vertebral column had been exposed long before discovery and all the units had suffered badly with the exception of two vertebrae which were completely inclosed in chalk. Isolated arches and scattered centra give approximate measurements and some details. Most of the caudal centra are preserved and their relationships are determinable with fair accuracy. A reasonable estimate, based on average measurements of units, places the total length of the vertebral column at about 15 feet. As the tail is slender it may have been appreciably longer than the estimate, half the length of the column.

*The cervicals.* Two distorted centra, lacking the arch, represent the cervical series. The first is from near the anterior end, probably immediately back of the axis. It is too badly eroded to give more than the gross proportions. The length was probably 50 mm. and the sub-equal circular articular faces about 58 mm. in diameter. The parapophysial facet is at about mid-height of the centrum.

The second centrum is from near the middle of the cervical series, probably about number six. It is 70 mm. long with sides deeply concave antero-posteriorly. Two prominent antero-posterior ridges on the ventral side are separated by a moderate concavity 25 mm. wide. The articular faces have nearly the same outline and diameters, about 70 mm. wide and perhaps 60 mm. high. They are regularly concave to a depth of about 10 mm. and lack the notochordal boss that is conspicuous in the cervicals of allied genera. The parapophysial facet is close to the anterior face at about mid-height. It is circular, concave, about 11 mm. in diameter, and not conspicuous in an anterior view. The neural canal is 25 mm. wide.

*The dorsals.* The dorsal series is represented by three poorly preserved centra, several isolated neural arches, and broken spines. Two centra, about the same in all details, are evidently

from the anterior part of the dorsal series. They are about 60 mm. long, deeply and uniformly excavated between the articular faces so that at mid-length the lateral diameter was probably about 40 mm. There is no evidence of a ventral keel. The articular faces are nearly circular in outline, about 66 mm. in diameter and moderately concave from near the margins. One of these centra shows no clear evidence of notochordal protuberances, but the other centrum shows a low boss in the center of one face. Reliable measurements of the neural canal cannot be made but it is narrower than in the cervical vertebra described above.

The third representative, a posterior dorsal, differs from the anterior units but slightly in its gross proportions. It is less excavated on the under than the other vertebrae and has well marked circular notochordal bosses.

None of the separate neural arches or the spines is complete. On one arch an attached rib is completely fused with the transverse process as in the posterior dorsals of *Ankylosaurus* (1) and *Palaeoscincus* (2). The process is 55 mm. long and 30 mm. wide and is directed upward and out at an angle of 40° from the horizontal. The spines are laterally compressed, on the average 7 mm. thick and about 25 mm. broad at mid-height. Most likely the height of none exceeded 80 mm. and none was greatly expanded laterally at the tip. One spine with a thickness of 6 mm. has its terminus expanded to 12 mm.

*The sacrum.* The vertebral support of the pelvic arch seems to have a gross structure and many details like those of *Paleoscincus rugosidens* and *Nodosaurus textilis*—three true sacrals united with sacro-lumbar and sacro-caudals to form a massive synsacrum. The true sacrum consists of three vertebrae so thoroughly coalesced as to leave no means of recognizing the individual units except that this part of the synsacrum bears three pairs of ribs. The ribs in the sacro-lumbar region arise inter-vertebrally where a distinct swelling marks the union of adjacent vertebral centra. The accompanying restoration recognizes three sacro-lumbar and two sacro-caudals, one less sacro-lumbar than in *Palaeoscincus*. There is no assurance that this is the correct interpretation for the two pieces into which the sacro-

lumbar section is broken do not fit together perfectly. The one unit of the sacro-caudal section is isolated with an obvious gap between it and the true sacra that may have included two rather than the one missing sacro-caudal of the restoration. However, the anterior end of the preserved sacro-lumbar is in part faceted and in part rugose as for the partial fusion of another unit to total the nine of the synsacrum of *Palaeoscincus*.

The centra of the true sacra are excavated on the ventral side by a shallow median longitudinal groove that includes the first of the sacro-lumbar and possibly the first of the sacro-caudals. The articular face of the anterior member of the coalesced lumbar is 57 mm. wide and 40 mm. high. The sacral centra average about 80 mm. in width. The free articular face of the last sacro-caudal is 77 mm. wide and 45 mm. high.

The ribs of the sacra are massive at their bases so as to occupy the full antero-posterior length of centra. The ribs arise from the level of the ventral surface of the centra and are so thoroughly fused as to leave no mark of the union. These ribs are comparatively slender at mid-length, particularly the third pair, but are markedly and sharply expanded at their outer end both antero-posteriorly and dorso-ventral. The expanded outer ends are coalesced to form a sacricostal yoke with an articular face about 145 mm. long and 50 mm. high. As none of the sacral ribs is preserved entire the breadth of the yoke is approximated as 325 mm.

The sacro-lumbar ribs rise from the base of the arch. They are broad and thick at their outer ends. The termini are distinctly faceted and rugose to underlap the ilium in semi-fusion. The sacro-caudal ribs arise from somewhat above the ventral surface of the centrum. None of these ribs, other than a small length fused with the last sacro-caudal, has been recognized in the rib fragments.

In a dorsal aspect the sacral composition appears relatively simple, with completely fused neural arches so that the spines form a continuous median ridge averaging about 13 mm. high and 10 mm. wide. The transverse processes of the three true sacra are comparatively thin, but broad so as to unite at both proximal and



distal ends. At mid-length, although greatly expanded, they are not united. Between the processes of the second and third sacra the intervening space as mid-length was probably about 35 mm. Between the first and second processes the space is considerably less and these processes may have been in contact throughout their length. The processes are closely applied to the upper surface of the sacral ribs, but were probably not fused save at the ends. The transverse processes of the sacro-dorsals are broad and are fused to the dorsal side of the ribs. The latter are slender at their proximal ends and the transverse processes apparently do not extend the full length of the rib. There is no direct evidence to help determine the process-rib development in the sacro-caudals.

*The caudal vertebrae.* There are twenty-five centra of caudal vertebrae preserved, most of them with arches fairly complete. In addition there are several separate arches that do not belong to the preserved centra and serve to fill in the gaps near the proximal end of the tail. Sixteen vertebrae, perhaps numbers 13 to 28, constitute an unbroken series.

The articular faces of the second (?) free caudal centrum are sub-equal, about 72 mm. wide and 62 mm. high. Their margins are beveled, but from near the periphery to the center they are markedly concave to a depth of 7 mm. on the posterior face. The lower part of the anterior and posterior margins is more deeply beveled than the rest of the margin for the articulation of the chevron. Circular notochordal bosses 8 mm. in diameter mark the center of each face. The posterior face is appreciably lower than the anterior so that the centrum is tilted forward when the ventral side is horizontal. The length of the centrum is 42 mm. It is moderately excavated, concave antero-posteriorly, between the faces, on the lateral and ventral sides. The arch is massive with stout zygapophyses that have broad articular faces. The strong spine is thin at mid-length, but is laterally expanded at the apex so as to be nearly as thick as wide. From the floor of the neural canal to the top of the spine the distance is 70 mm. The transverse processes are stout, sub-circular in cross-section, and about 54 mm. long. Measured along the transverse processes

the arch is 162 mm. wide. The processes arise from the superior side of the centrum at the base of the arch and are directed slightly downward from horizontal and very slightly backward.

There is little change in proportion from the first to the fourth (?) free caudal. The length of the fourth centrum is 46 mm. and the articular faces are nearly circular with a transverse diameter of 63 mm. There is evident the beginning of two parallel ridges that bound an antero-posterior excavation on the ventral side, a development that is characteristic of all of the following caudals. None of the caudals is in any wise wedge shaped as in *Stegosaurus* and *Palaeoscincus* (2) and there is no indication of a sharp bend of the tail from the level of an elevated body to the ground. At the level of approximately the eighth free caudal there is little difference in the centra from that of the fourth caudal except that the notochordal boss is much less prominent and in following vertebrae seems to be absent. The transverse process, probably diminished in length, is still robust at its base and arises from slightly below the base of the arch.

At the fourteenth free caudal the centrum is as high as wide, 53 mm. in diameter across the articular faces. It is 50 mm. long and is deeply excavated on the sides. The ventral antero-posterior sulcus is narrow and sharply defined. The transverse process is a thin horizontal projection of little extent arising from slightly above mid-height. The arch is narrow and the spine is a low sharp keel rising 25 mm. above the floor of the neural canal and is essentially continuous from one vertebra to the next.

The maximum length of the caudal centra, 55 mm., is in the region of the eighteenth where the articular faces are 47 mm. wide and 50 mm. high. The following vertebrae decrease regularly but very gradually in length and diameter of the centra so that at the thirtieth the length is 47 mm. and the articular faces 35 mm. in width and height. The arch is reduced to a low ridge over reaching the following vertebra and with anterior zygapophyses extending forward to articulate well in advance of the front margin of the centrum.

The next to last vertebrae preserved, about the thirty-seventh, is 43 mm. long and 29 mm. in diameter at the articular face of the

centrum. It is possible that the tail was a foot or more longer than the preserved length and almost certainly flexible to the tip.

*The chevrons.* All of the chevrons articulated intervertebrally and none was fused with a centrum. Two complete chevrons are preserved and parts of several others from the middle of the tail are recognizable. The complete chevrons are bridged across the articular ends but a large haemal opening is left. In one specimen this is 13 mm. wide and 22 mm. high. Parts of chevrons sufficiently large to indicate a position near the proximal end of the tail have a double unbridged articulation.

*The ribs.* There are surprisingly few rib scraps for such an otherwise complete representation of skeletal parts. No pieces have been identified as cervicals and only eight can be assigned to the thorax on the basis of their articulations. Seven of these show discreet articulation of tubercle and capitulum widely separated. One rib is fused to the transverse process from capitulum to tubercle—a length of 58 mm. This rib, from about midlength of the dorsal series, rises in a sharp upward curve to the height of the spine. Beyond this the curvature is so slight as to give the appearance of straightness in a length of about 200 mm. This part of the ribs was directed laterally almost in the horizontal plane. From the very slightly curved mid-length section the rib curves most rapidly to its distal end where it must have been directed out and down at an angle little more than 60° from the horizontal.

The tip of this rib is not preserved but the rate of decrease in diameter of the preserved part indicates a small or pointed extremity. The length along the ventral side of the preserved part of the rib is 570 mm. The distance across the body along this rib is about 120 cm.

In cross section this rib is T-shaped for some distance beyond the tubercle with a breadth across the flattened dorsal surface of 24 mm. and a depth of 19 mm. All of the ribs that have this part of their length preserved show a slight antero-posterior expansion of the top of the T at a distance of about 70 mm. from the tubercle or something over 100 mm. from the median line of the vertebrae. The expansion is "cross grained" or transversely rugose on its

upper surface. This possibly marks the position of longitudinal tendons or, more likely, the position of a chief antero-posterior line of dermal plates as is indicated elsewhere. This "swelling" of the dorsal portion of the ribs is not comparable in development or position to the "uncinate processes" of *Ankylosaurus* as noted by Brown (1).

The attitude of these ribs indicates a relatively broad flat body. In keeping with this is the fact that none of the ribs has truncated ends for cartilaginous continuation to form a rounded body cavity but all are very slender. Of the ribs in general it may be said that the most massive has a width of 32 mm. and a thickness of 17 mm.

Two pointed rib ends were found fitted closely into the concavity beneath low-conical dermal plates, both indicating natural association. It is unlikely that in an animal of such relatively light construction the armor would extend beyond the sides of the body cavity to the under side and it is suggested that the edges of a flat body were fringed by pointed plates.

#### THE GIRDLES

*The shoulder girdle* is represented by a large fragment of the right coraco-scapula including the entire glenoid fossa and the coracoid foramen. The bone has been flattened by the weight of inclosing sediments and measurements are therefore of little value. The glenoid fossa is about 113 mm. from anterior to posterior margin, probably the normal measurement. The transverse width of this articular surface, probably four-fifths of the original measurement, is 65 mm. It is pitted and rugose, particularly in its anterior half. The coracoid foramen, 12 mm. in diameter, pierces the coracoid 35 mm. above the outer and 50 mm. back of the anterior margin of the glenoid and is directed downward and backward. However, on the inner side the foramen is 48 mm. above the margin of the glenoid. The coracoid is indistinguishably fused with the scapula.

A sharp elevation, the lower end of an acromian ridge, arises on the scapula near the posterior end of the glenoid and about 45 mm. above its margin.

*The pelvic girdle* offers little in the way of definite information other than that presented in connection with the sacrum. The

right ilium is represented by a considerable section at midlength including the sacral union, the acetabulum and the lateral margin. Of the left ilium a small section fused to the sacral yoke and a few scraps are all that was recovered.

It is evident that the ilia departed little from a plane and were nearly horizontal. The acetabulum is shallow and ill defined but seems to have been confined to the ilium. The nature of the articulation of the ilium with pubis and ischium is puzzling, particularly so in the absence of fragments that might represent pubis and ischium. If the writer has correctly interpreted the poorly preserved sacro-iliac relation the pubis and ischium, if present, underlapped the ilium and abutted against the lower half of the yoke formed by the union of the greatly expanded distal ends of the sacral ribs. An apparently separate unit preserved on either side occupies part of the space along the sacral yoke below the ilium and in contact with the yoke. This unit is abraded and may represent the pubis or ilium, or part of both.

A peculiar laminar condition at the inner part of the dorsal side of the ilium is interpreted as a plate-like dermal ossification closely united with the ilium. The accompanying cross-section sketch expresses the suggested relationship here described.

#### THE LIMBS

The fore limb is represented by complete right humerus, radius, and ulna, and the distal ends of the left radius and ulna. Two isolated metapodials belong to the fore foot.

The humerus is less crushed than other parts and apparently approximates its original proportions. Its gross appearance is stout and massive and in reality it was strong but delicately constructed. The striking features are the small shaft diameter, remarkable proximal expansion into a great radial crest, a distinct head directed posteriorly at a large angle with the axis of the bone, and laterally expanded distal extremity with radial and ulnar articulations confined almost entirely to the anterior face of the expansion. The humerus is 377 mm. long, 220 mm. across the proximal expansion, with a minimum shaft diameter of 55 mm., and a distal expansion of 160 mm.

The head is strongly convex, circular in outline with an average

diameter of 88 mm., and is sharply set off at all parts of its margin. The deeply pitted articular face is directed back from the axis of the shaft at an angle of approximately  $45^{\circ}$ . The head is scarcely visible in an anterior view. In a posterior view it is equally divided by the axial line of the bone. The radial crest is a remarkably broad plate-like expansion curving broadly forward so as to form a pronounced concavity on the upper anterior half of the humerus. Somewhat below the mid-length of the outer margin of the deltoid is a pronounced rugose swelling for muscle attachment. The crest gradually becomes confluent below with the shaft at a third of its length from the distal extremity. Here the bone is nearly circular in cross section, and has a fairly sharply outlined median cavity about 20 mm. in diameter.

The distal condyles are distinctly separated by a broad shallow groove. Both are sharply outlined, circular in pattern, and markedly convex with deeply pitted surface. The radial articulation is somewhat the larger.

The confinement of the articular surface of the head to the posterior (upper) surface and the development of the radial and ulnar articulation on the anterior (lower) surface clearly indicates a normal horizontal position for the humerus.

*The radius*, now flattened antero-posteriorly, was probably about equidimensionally expanded at its proximal end with a sub-circular concave articulation 60 mm. or more in diameter. Below the proximal expansion the diameter of the bone decreases to about 35 mm. in the first fourth of its length and from here to the distal end there is a gradual lateral expansion to a width of 95 mm. The original thickness of the distal end was possibly as much as 57 mm. The length is 270 mm. On the ulnar margin near the distal end of the radius is a well marked flattened area for the gliding contact with a similar area on the ulna.

*The ulna* has suffered more from compression than the other bones of the fore limb and gives indisputable evidence of the spongy or hollow interior in sharp contrast with the very dense outer layers. The proximal articulation is considerably expanded both laterally and forward. At the level of this articulation one bone is 115 mm. deep (antero-posteriorly). Originally



this measurement was probably slightly less. Laterally across the articulation the width was originally near 70 mm. A stout olecranon extends 90 mm. above the articular surface. From the expansion of the distal articulation the bone tapers gradually to its least diameter, 50 mm. x 23 mm. at one-fourth the total length from the proximal end. On the radial edge near the proximal end is a distinct facet for articulation with the radius. The distal end is somewhat spatulate, 25 mm. thick and expanded to a width of 67 mm.

The hind limbs are represented by an almost complete right leg and foot and a left femur, tibia, fibula, astragalus, and calcaneum.

*The femur*, although badly crushed, seems to have undergone important dimensional changes only in its mid-length where the thickness has been greatly reduced by crushing together the opposite walls of the central cavity without greatly increasing the other diameter. The distal end has been abnormally expanded by pressure which has reduced the antero-posterior extent of the tibial and fibular condyles. The bone is 485 mm. long with lateral expansions at proximal and distal ends of 165 mm. The latter was originally probably not over 120 mm. The transverse diameter of the shaft at one-third the length above the distal end, is now 70 mm. Originally this measurement was very slightly less and the diameter at right angles was probably near 60 mm.

The articular surface of the head was low convex, deeply pitted and circular in outline with a diameter of about 75 mm. The articulation was confined largely to the anterior (upper) side of the bone in such a way that the femur must have been directed horizontally or possibly slightly above the horizontal. The major trochanter is comparatively massive and strongly rugose. The lesser trochanter one-third the length of the bone below the proximal end is also markedly rugose and is more of an elongate boss than a ridge.

A straight, fairly sharp "adductor" ridge is continuous along the axis of the bone on the anterior (upper) side from the proximal end to within about 100 mm. of the distal condyle.

The tibial and fibular condyles are not evident in an anterior

(superior) view. Although remarkably developed their articular surfaces are directed back (down) nearly at right angles to the long axis of the bone. They are separated by a wide deep intercondylar groove on the posterior (inferior) side that is faintly evident on the distal end of the bone. It is evident from the position of the distal condyles and the articular face of the head that progression on land demanded that the femur be directed well forward as well as horizontally for the articular surfaces lie in the same plane.

*The tibia* has a relatively slender shaft with greatly expanded proximal end and an even more remarkable laterally expanded distal end. The length of the bone is 365 mm. and at mid-length the sub-circular cross section is 55 mm. in diameter. The shaft expands rapidly in all directions toward the proximal end to a somewhat circular articular surface measuring about 110 mm. long and 120 mm. wide. This surface is concave and divided into postero-lateral lobes by a broad and deep posterior sulcus. The inner lobe occupies by far the greater part of the total articular surface. The surface as a whole is directed somewhat backward from the axis of the shaft indicating clearly that the lower leg was normally flexed at angle of about  $90^\circ$  with the femur. On the inner posterior side of the shaft of the right tibia at about mid-length of the bone is a pronounced, somewhat rugose swelling. This portion of the left tibia is abraded and gives no evidence as to whether the swelling is normal. The distal end is thin and greatly expanded laterally with the greatest expansion, 165 mm., somewhat above the distal extremity. The anterior face of the inner disto-lateral margin is beveled in such a manner that it conforms to the proximal articular face of the first metatarsal as is indicated later. The distal margin is a straight, comparatively sharp edge at right angles to the shaft. There are no distinct terminal articular facets for the reception of tarsal bones.

On the anterior face of the inner distal expansion of the right tibia is a laterally elongate, slightly swollen but smooth area 65 mm. wide and 40 mm. high. This area marks the position of the completely fused *astragalus*. The left unit, less well preserved is not so completely fused and shows the boundaries of the as-

tragulus clearly. The astragulus does not form any part of the border of the tibia but is inclosed on the outer and lower sides by an irregular growth of bone. On the right tibia this inclosing growth appears to be an overlap by the tibia, but on the left tibia the inclosing mass has the appearance of being a separate ossification. It is possible that the irregular ossifications about the inner distal margins of the tibia represent the partial ossification of "tarsal cartilage."

The *calcaneum* is not united with the tibia but fits into an irregular surface on its anterior face so as to take part with that bone in its outer distal margin. In outline the calcaneum is roughly circular with lateral diameter of 60 mm. The upper margin which abuts against the distal end of the fibula is truncated and 27 mm. thick. Its lateral and lower margins are comparatively thin.

The *fibula* is a slender bone 315 mm. long with comparatively thin laterally expanded ends. The proximal end is faceted on its inner anterior surface for articulation with the outer posterior side of the outer lateral expansion of the tibia's proximal articular surface. Apparently the fibula does not form an important part of the articulation with the femur. At about one third the length of the bone from its proximal end the fibula is swollen and rugose for muscle attachment on its outer side. Below the swelling it is nearly circular in cross section for a short distance with diameters of 22 mm. and 25 mm. The distal extremity is laterally expanded to 63 mm. and truncated at right angles to the axis to abut against the straight upper face of the calcaneum. The distal end of the fibula lies entirely on the anterior face of the femur, the overlap starting on the inner posterior side of the fibula about a third the length of the bone above its distal end.

The *tarsus*, other than the astragulus and calcaneum as described above, was probably cartilaginous. It seems impossible for other distinct ossifications to have existed, for all of the metatarsals of the right foot, excepting the first, were preserved at the proximal end of the tibia in their exact relationship.

The *metatarsals* of the left foot, five in all, are preserved. The first was slightly displaced but the others seem to have been little

disturbed. The first metatarsal of the right foot is missing, but the others are well preserved, although they were weathered out and slightly displaced when found. The metatarsals evidently were arranged fan-wise in the plane of the distal expansion of the tibia and articulated closely with its distal edge. Probably the flexibility of the metatarsal-tibia union was closely limited and did not include an actual gliding of the metatarsal articulations over the tibia. The first metatarsal was directed laterally and seems to have fitted with a deeply cupped proximal articulation close to the lateral expansion of the femur so as to have been nearly fixed. Excepting the first, which simulates a low frustrum of an oblique cone, the metatarsals are short flat bars with ends slightly thickened and laterally expanded. From the first to the fifth they measure 30 mm., 66 mm., 95 mm., 105 mm., and 90 mm. in length. The distal articular surface of all but the first metatarsal is considerably wider antero-posteriorly than the articulation surface of the first phalanx. This and a similar condition of the following phalanges, particularly the distal end of the last but one, shows a remarkable flexure of the toes as indicated in the accompanying figure (Pl. II, fig. 6).

Four of the *phalanges* of the right hind foot are missing, but their absence does not obscure the picture. The first phalanx of the first digit was not recovered. In the second digit the second phalanx is missing. There is enough difference in the terminal phalanges of these two digits, both of which were weathered out but recovered, to determine their position. Of the third digit the first two phalanges were in position and the third and fourth were found together but slightly displaced. All of the phalanges of the fourth digit were weathered out and only the first two and the terminal unit were recovered. The first and second phalanges of the fifth digit were in place and the other two, although disassociated, were recovered. The formula is almost certainly 2, 3, 4, 5, 4.

The first phalanx of the second digit is almost as long as wide. All the other phalanges excepting, perhaps, number one of the first digit which is missing, and the terminal phalanges are considerably wider than long. The first units are about twice as wide

as long and some of the following phalanges are about three times as wide as long. The terminal phalanges are all longer than wide, broadly spatulate with thinned lateral and distal margins. All are slightly recurved with strongly convex anterior surfaces. Both surfaces are deeply pitted and grooved. In some of the terminal phalanges a small foramen extends through the bone piercing the outer and inner surfaces near each lateral margin not far from its proximal end. The distal edge of all is pierced by openings extending into the phalanx as though to connect with grooves or openings on the anterior surface. Such a connection has been traced in some of the units. These terminal phalanges were undoubtedly incased in a horny sheath.

#### THE ARMOR

The armor is represented by about one hundred nearly complete units and perhaps double this number of pieces sufficiently large to show the size and shape of the originals. In addition there are many fragments that give very little information. It is not likely that any important part of the dermal armor is missing; probably almost all of the dermal scutes are preserved. Even with such a remarkable collection it is impossible to reconstruct the armor satisfactorily, but a few points are fairly definite. In the first place, there is no evidence of a rigid armor through the fusion of separate units. Among the entire number of plates none has margins that are truncated or shows the least evidence of attachment to other plates. In the second place, there is a delicacy of construction in the plates that bespeaks lightness throughout. In the larger conical and triangular plates the base is deeply excavated, in some cases producing almost a hollow spine. Some of the larger plates are crushed as though the interior were of porous bone in marked contrast to the comparatively dense exterior. A third apparently justified conclusion, that the dermal plates were more or less isolated in an otherwise bare skin, is based on a general absence of tiny ossicles such as pebbled the skin of some dinosaurs. A very few small disk-like ossicles are present, for the most part associated with the legs. If any considerable part of the body were covered with ossicle

studded skin large patches of these ossicles could scarcely escape preservation with such an otherwise complete representation of dermal armor.

Some suggestion of the position of the various types of plates is gained through their association with various skeletal parts, in some cases sufficiently repeated to oppose accidental association. For instance, several slender ribs were found tipped by low keeled sharply pointed plates that fitted so closely as almost to preclude displacement and reassembly. The outstanding feature of the scute pattern seems to have been an arrangement in longitudinal rows on the dorsal surface of the body. In this the most conspicuous was a row of laterally compressed triangular plates standing vertically on either side of the median line at a distance of about four to five inches. It is because of the comparatively great height and narrow bases of this series of plates that a broad support is considered necessary. This is thought to have been supplied by the expanded rugose part of the upper surfaces of the dorsal ribs as described above. None of this series of plates is entirely complete but many show all essentials. The largest have bases about 180 mm. long and 40 mm. wide, and a height of 100 mm. Probably the largest were at mid-length of the body. From this extreme of high triangular plates there is a gradation into plates with broad bases, low keeled or spined, that probably formed additional lateral rows and the ends of the inner series. All of the keeled plates are asymmetrical. An average of this series is 70 mm. wide and 100 mm. long, with the longitudinal crest rising to an apex 40 mm. high near the anterior (?) margin. Apparently the lateral margins of the body were fringed with low pointed plates that actually tipped the ends of the ribs. Probably the high crested scutes were confined to the region in advance of the sacrum. In close contact with the dorsal surface of one ilium was an exceptionally large plate, perhaps as much as 100 mm. wide and 150 mm. long, with a low rounded keel. There is no evidence that conspicuously spinose plates extended to the tail. In the collection are two or more spines in the form of oblique cones, the best preserved of which has a base 70 mm. wide and 100 mm. long. The apex, 70 mm. high, overhangs one



margin in the direction of the long axis of the base. This plate with deeply excavated under surface was found closely applied to the outer surface of the proximal end of the right tibia and is thought to represent a part of the limb armor. Much smaller, low keeled plates were associated with radius and ulna.

#### RELATIONSHIPS

In referring the material described in the preceding pages to the genus *Hierosaurus* Wieland the writer is aware that it might have been assigned to a new genus with good reason. Although certain plates in the type of *Hierosaurus* are duplicated in every detail in the assemblage described as *H. colei*, the same holds true for certain plates of several other distinct genera. However, until fairly complete remains of more than one genus are found in the chalk beds it seems advisable to assume that all dinosaur remains in this formation represent a single genus so long as strong contrary evidence is lacking.

*Hierosaurus colei* presents a peculiar combination of characters that confuse relationships. If it was a truly aquatic dinosaur one might well expect modifications that set it off sharply from its most nearly related land-living forms. It differs from most of the armored dinosaur genera in the apparent absence of more or less coalesced armor units to form rigid transverse bands. In this respect it resembles the body armor of the European *Struthosaurus*. Too little is known of the skull of *Hierosaurus* to furnish adequate comparison other than that the dermal plates, few in number, would suggest the subfamily Panoplosaurinae Nopsca which includes *Palaeoscincus*, *Panoplosaurus*, *Edmontonia* and perhaps *Hierosaurus*, *Scalosaurus*, and *Stegopelta*. It seems to the writer that this character alone is not necessarily diagnostic. The teeth of *H. colei* are very much like those of *Stegosaurus*; in fact, they would probably have been placed in that genus had they been found disassociated and in sediments of suitable age. This does not prove a close affinity with *Stegosaurus*, however, for there are many fundamental differences, one of which is an additional toe on the hind foot of *Hierosaurus*. It seems likely that *Hierosaurus* turned to an aquatic adaptation not long after the

start toward diversity among the stegosaurid group. One culmination of this diversity was *Stegosaurus* and another a distinct trend toward the more or less perfectly armored Nodosauridae with such startling products as *Paleoscincus*. *Hierosaurus* seems to have traveled a short distance along the normal nodosaurid development and then turned toward aquatic adaptation. It combines in this way a more ancient foot structure, in some respects, and a more primitive dentition than most of the Nodosauridae. To the writer it seems most logical to place *Hierosaurus* in the family Nodosauridae and, regardless of its many differences, with the panoplacaurinid group.

#### HABITS

That *Hierosaurus colei* was strictly aquatic seems fairly certain. The limb bones are hollow and of comparatively delicate structure. The armor, too, shows no tendency to fuse into a more or less solid carapace such as was useful to the smaller of the land dwelling relatives. The attitude of the limbs was not such as to permit efficient progress on the land. The hind foot at least was distinctly paddle-like with movement between the lower leg and the metatarsals limited, but the toes were capable of remarkable backward flexing.

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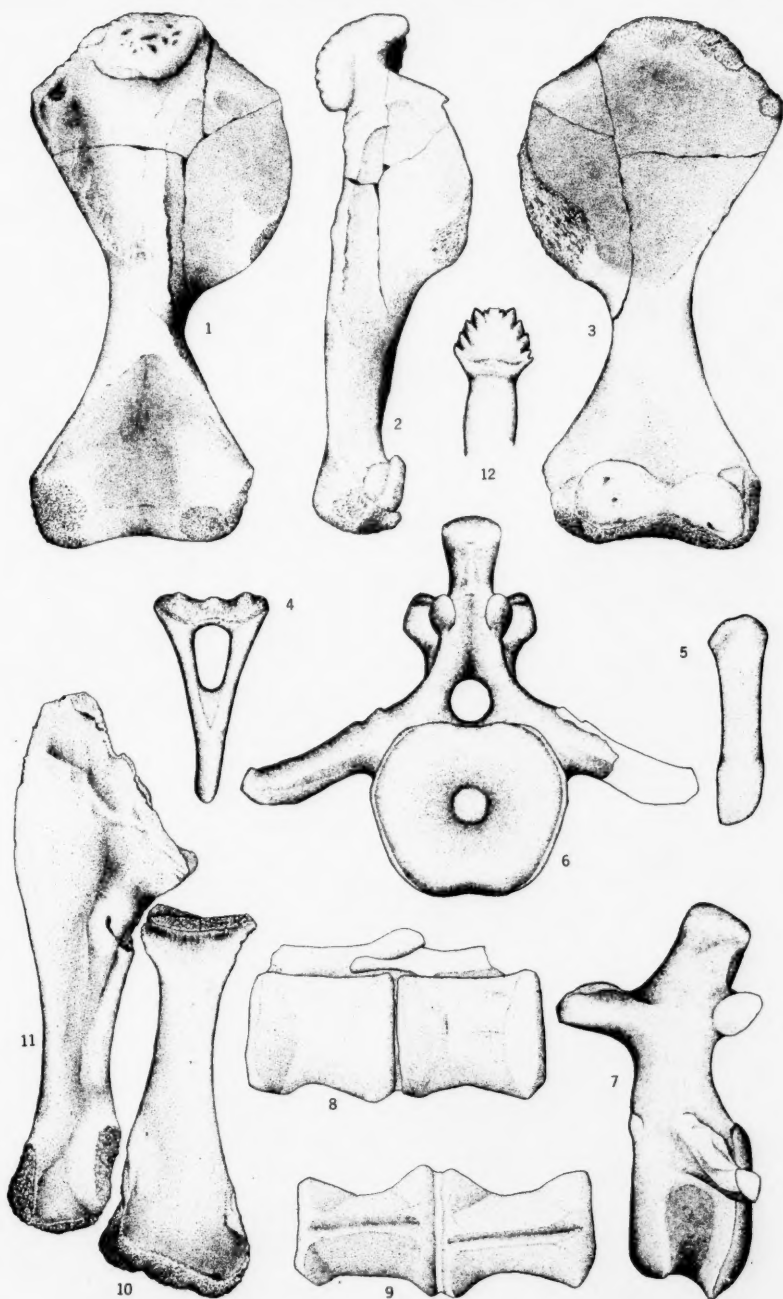
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PLATES

## PLATE I

### HIEROSAURUS COLEII MEHL

- Figs. 1-3. Posterior, outer lateral, and anterior views of right humerus of type,  $\times \frac{1}{2}$ .
- Figs. 4, 5. Posterior and left lateral views of bridged chevron from about mid-length of tail of type,  $\times$  about  $\frac{1}{2}$ .
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- Fig. 12. Inner view of isolated mandibular (?) tooth of type,  $\times 2$ .



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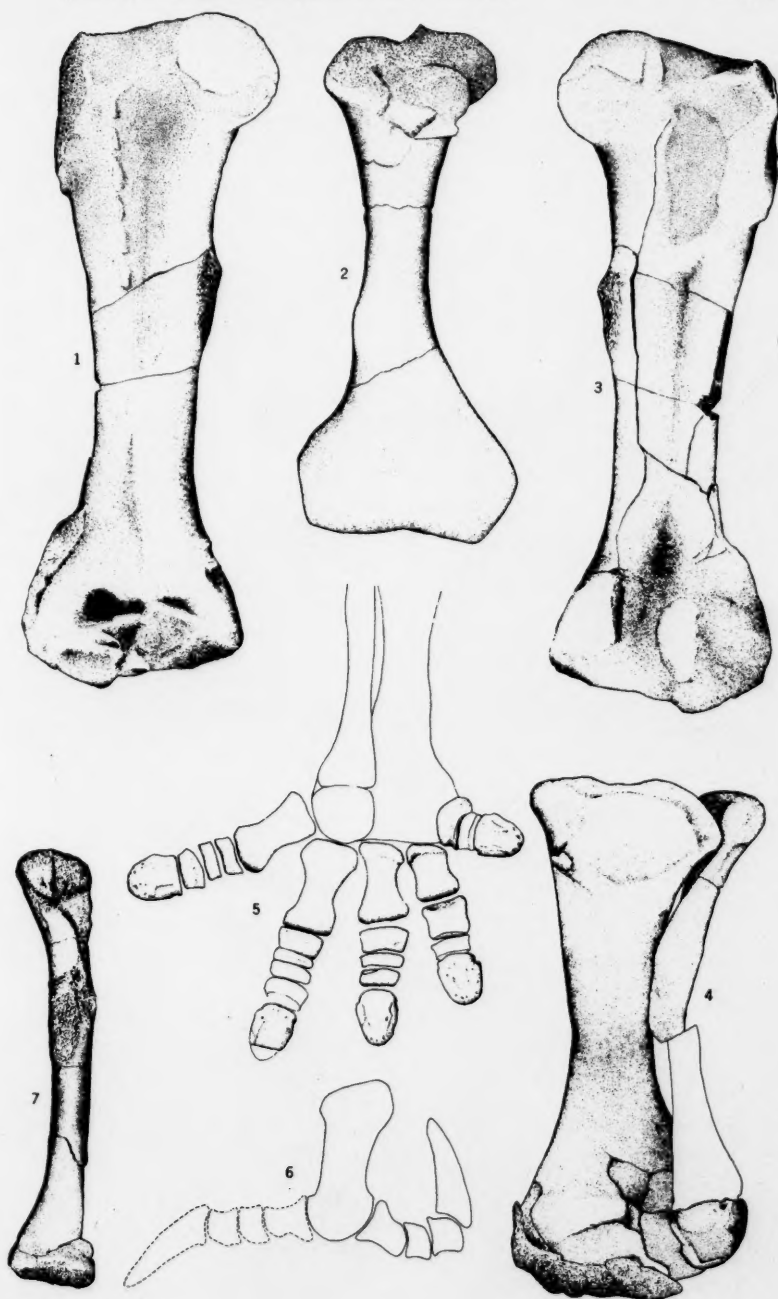
HIEROSAURUS COLEII

## PLATE II

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Fig. 6. Lateral view of third digit to show the limits of flexure.  
Fig. 7. Anterior view of right fibula of type,  $\times \frac{1}{3}$ .





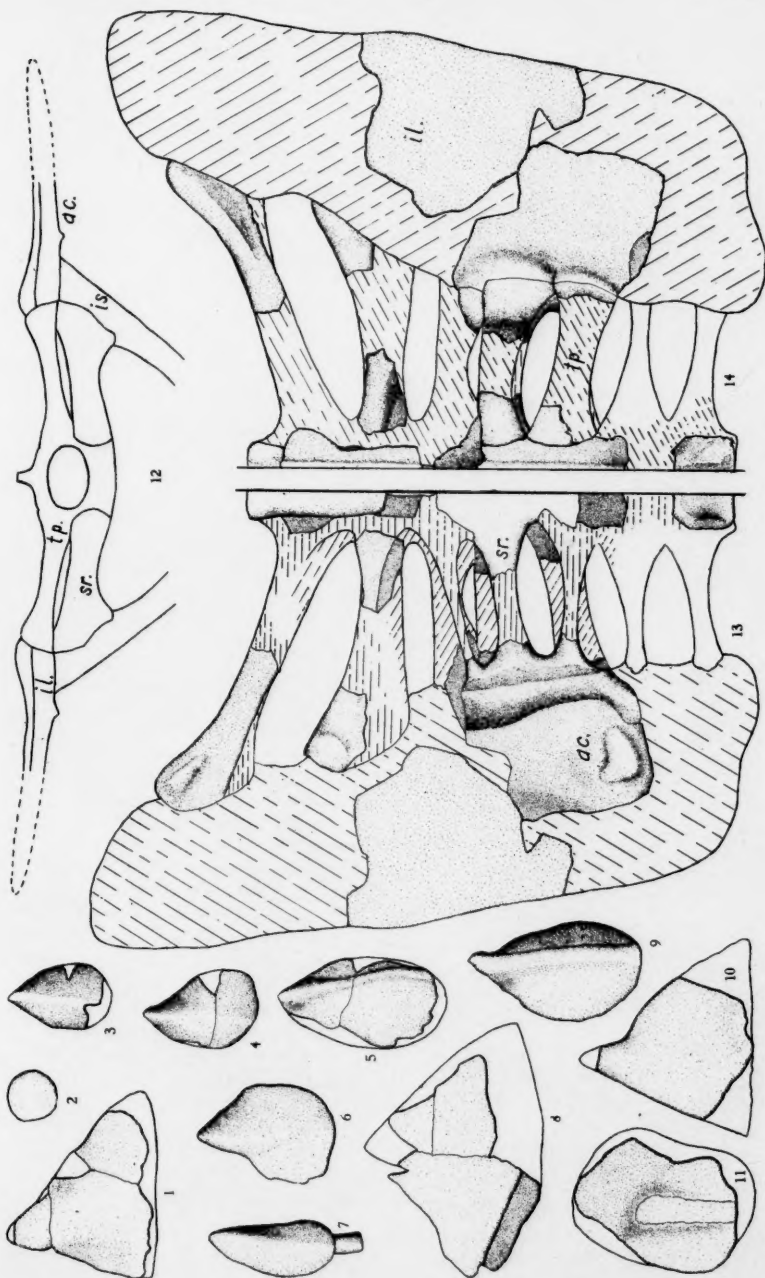
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### PLATE III

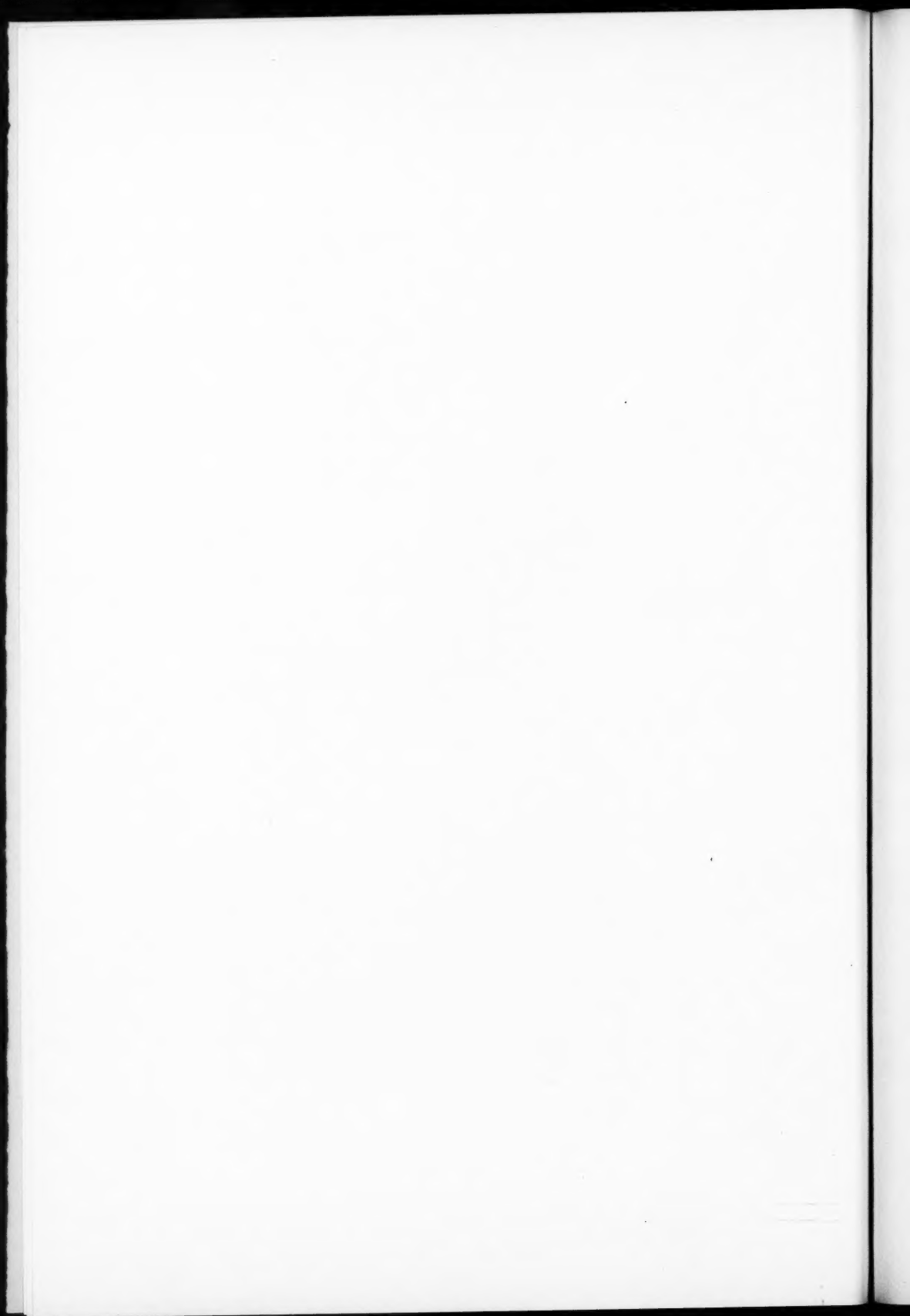
#### HIEROSAURUS COLEII MEHL

- Figs. 1-11. Dermal plates of type,  $\times \frac{1}{4}$ . Figs. 1, 8, and 10 are lateral views of some of the larger triangular plates with transversely expanded, excavated bases; fig. 2, superior view of flat disk-like unit; figs. 3, 4, and 6, superior views of low asymmetrical cones; figs. 9 and 11, superior views of low keeled plates with broadly arched bases; fig. 12, superior view of low cone on rib terminus; fig. 11, a broad flat plate with median (broken) keel.
- Figs. 12, 13, 14. Cross section view of pelvic complex, and inferior and superior views of right half of pelvis in type,  $\times \frac{1}{4}$ . *ac.*, acetabulum; *il.*, ilium; *is.*, ischium; *sr.*, sacral rib; *tp.*, transverse process.



M. G. MEHL

HIEROSAURUS COLEII



# SILURIAN CEPHALOPODS OF THE PORT DANIEL AREA ON GASPE PENINSULA, IN EASTERN CANADA

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Port Daniel is on the southern coast of Gaspé peninsula, near the eastern end of Chaleur Bay, on the western margin of the Gulf of St. Lawrence, in eastern Canada. It is about 115 miles south of the western end of Anticosti Island. Niagaran strata are exposed here from Indian Point and West Point, which are southwest of Port Daniel Bay, to Anse-à-la-Vieille, about 6 miles east of this bay.

Silurian fossils were identified from these strata by Sir William Logan in 1844, in the Report of Progress<sup>1</sup> of the Geological Survey of Canada for that year, which, however, was not pub-



lished until 1846; and these strata were recognized more definitely as Niagaran in his *Geology of Canada*,<sup>2</sup> published by the same Survey in 1863.

The latter publication contains a vertical section of the Niagaran strata in the Port Daniel area, indicating their chief lithological differences and including names of some of the fossils identified. However, no division of these strata into distinct formations was attempted until 1926 when Charles Schuchert and one of his students, J. Doris Dart,<sup>3</sup> proposed the following 6 formations, named in descending order:

Indian Point formation.....	194 ft.
West Point limestone.....	1,445 ft.
Bouleaux formation, limestone and shale.....	800 ft.
Gascons muddy and shaly sandstone.....	1,800 ft.
La Vieille limestone, sandstone, and conglomerate.....	455 ft.
Clemville formation.....	385 ft.

The present paper is a study of the Silurian cephalopods found in the Port Daniel area of the Gaspé peninsula, but a description of *Geisonoceras danielensis*, an Ordovician species, has been added since it was found in the same general region, and is the only Ordovician species so far found in that area. Moreover, a description of *Gaspocyrtoceras telleri*, from the Racine of Wisconsin, is introduced since the latter appears congeneric with *Gaspocyrtoceras cooperi* from the Port Daniel area.

The Port Daniel cephalopods here studied were secured by various collectors, chiefly by Charles Schuchert, Stuart A. Northrop, G. Arthur Cooper, J. Doris Dart, and Josephine Wells. They now are preserved chiefly in the Peabody Museum at Yale University, in the National Museum of Canada at Ottawa, and in the U. S. National Museum. The holotype of *Bickmorites barbensis* is in the Redpath Museum of McGill University, in Montreal.

Fortunately almost all of these cephalopods can be assigned to definite horizons. This is true not only of those collected in 1925 and in subsequent years, but also of most of those collected before this date. At first an element of uncertainty appeared to exist about those specimens collected in the Anse-à-la-Barbe area

previous to 1925, since both the Gascons and the Bouleaux formations are exposed here. However, in view of the fact that numerous cephalopods are known definitely to have been obtained near the top of the Gascons formation in the Anse-à-la-Barbe area, while not a single specimen has been discovered here in the overlying Bouleaux, it appears reasonable to assume that those cephalopods collected in the Anse-à-la-Barbe area previous to 1925 also came from the Gascons formation. In the following list, those species listed among those from the Gascons formation which were collected previous to 1925 are marked by an asterisk (\*), except in those cases where subsequent collections give independent evidence of their presence at that horizon.

# I. Cephalopods from the Port Daniel area

## A. Silurian species

### Indian Point formation

*Geisonoceras* sp. (Indian Point)

*Protokionoceras* *microlineatum*

*Spyroceras* *daniellense*

*Spyroceras* *orientale*

*Spyroceras* *northropi*

*Cycloceras* (?) *gaspense*

*Perioidanoceras* (?) *chaleureuse*

### West Point formation

*Spyroceras* *chaleureuse*

*Cyrtorizoceras* *gasconsense*

*Gaspocyrtoceras* *cooperi*

*Ormoceras* sp. (West Point)

### Bouleaux formation

*Kionoceras* *bouleauxense*

*Kionoceras* sp. (Bouleaux)

*Cyrtorizoceras* sp. (Bouleaux)

*Calocyrtoceras* (?) *bouleauxense*

*Dartoceras* *nodosum*

*Gasconsoceras* cf. *obesum*

### Gascons formation

\**Orthoceras* *chaleureuse*

*Geisonocerina* *barbensis*

\**Geisonoceras* (?) sp. (Anse-à-la-Barbe)

*Kionoceras* *barbense*

*Protokionoceras* *perstrigatum*

\**Protokionoceras* *imperator*

*Spyroceras* *barbense*

*Spyroceras* sp. (Morrin)

*Spyroceras* sp. (Anse-à-la-Barbe)

*Dawsonoceras* sp. (Anse-à-la-Barbe)

- \**Rizoceras dartae*
- Rizoceras* (?) *atlanticum*
- Rizoceras pocilliforme*
- Rizoceras infundibuliforme*
- \**Cyrtorizoceras schucherti*
- Cyrtorizoceras diagonale*
- \**Cyrtorizoceras barbense*
- \**Gasconsoceras pulchellum*
- Gasconsoceras planiventrum*
- Gasconsoceras obesum*
- Gasconsoceras cascapiense*
- \**Bickmorites americanus*
- Bickmorites barbensis*
- Mandaloceras subgracile*
- \**Mandaloceras erectum*
- \**Hexameroceras inflatum*
- Hexameroceras erectum*
- Hexameroceras schucherti*
- \**Hexameroceras* (?) *occlusum*
- Phragmoceras altum*
- \**Phragmoceras northropi*
- La Vieille formation
- Armenoceras wellsae*
- Armenoceras gasconsense*
- Huronia gaspensis*
- Amphicyrtoceras cooperi*
- Clemville formation
- Orthoceras clemvillense*
- Spyroceras* sp. (Clemville)

## B. Ordovician species

## Mictaw formation

*Geisonocerina danielensis*

## II. Cephalopod from Milwaukee, Wisconsin

## Racine formation

*Gaspocyrtoceras telleri*

Any attempt to correlate the Silurian cephalopods of the Port Daniel area with those elsewhere on the American continent meets with the difficulty that cephalopods usually are rare in most Clinton strata and in all Cayugan formations. Even in the Lockport formations they are rare over wide areas.

In the Clinton, cephalopods are common only in the Manistique formation of northern Michigan and in corresponding strata in the Lake Timiskaming area; also in the Jupiter and Chicotte formations of Anticosti. All of these are of Upper Clinton age and of northern distribution.

In the Cayugan, cephalopods are rare at all localities known.

In the intermediate Lockport formations, cephalopods are rare especially in the Brownsport and Louisville formations, and they are relatively rare also in the Laurel and Waldron formations; all of southern distribution. They are abundant, however, in the Liston Creek and Huntington formations of Northern Ohio, the Racine of southeastern Wisconsin and adjacent Illinois, the Port Byron of northwestern Illinois and the adjacent part of Iowa, the Cedarville of southwestern Ohio, and the Lockport and Guelph of northwestern Ohio, southern Ontario, and adjacent New York. They are relatively abundant also in the Attawapiskat formation of the area southwest of Hudson Bay. Again, this is a more northern distribution than that of the areas in which cephalopods are relatively rare.

It would be interesting to know what ecological conditions would favor the distribution of cephalopods as known at present in Palaeozoic rocks.

As far as present observations permit it appears that wherever cephalopods are abundant the mobile gasteropods also are relatively common, while the sedentary brachiopods, corals, and bryozoans are less common here than elsewhere. On the contrary, where the brachiopods, corals, and bryozoans are common, cephalopods usually are rare.

Possibly segregation is due occasionally to violent storms resulting in strong ocean currents which sweep along the mobile forms into areas where sedentary life is less abundant, overwhelming these mobile forms with muddy and arenaceous deposits. This might account for local segregations of cephalopods and gasteropods, but would not account for their relative absence over large areas.

In view of the scarcity of cephalopods in most Clinton strata they serve only rarely for purposes of definite correlation of horizons at remote distances from each other.

Neither one of the two cephalopods described from the Clemville formation suggests definite correlation with any other known Silurian formation, but the associated fossils listed by Schuchert and Dart indicate Clinton age, preferably Lower Clinton.

Among the cephalopods described from the La Vieille formation, *Huronia gaspensis*, in association with *Armenoceras*, suggests the Manistique formation of Northern Michigan and its equivalent in the Lake Timiskaming area; also the Jupiter and Chicotte formations of Anticosti Island. In the present state of our knowledge of the vertical range of *Huronia*, its presence suggests Upper Clinton age.

The two species of *Bickmorites* in the Gascons formation are closely related to the genotype *Bickmorites bickmoreanus* (Whitfield) from the Liston Creek formation of Northern Indiana, and to *Bickmorites welleri* Foerste from the Racine of the Chicago area. Moreover, the association of the genera *Mandaloceras*, *Hexameroceras*, and *Phragmoceras* at the same horizon suggests correlation with the Racine of Wisconsin and adjacent Illinois, and the equivalent Cedarville formation of southwestern Ohio; also with the Port Byron formation of northwestern Illinois and adjacent Iowa and the Guelph of southern Ontario and northwestern Ohio. A similar association of genera occurs also in the Liston Creek and Huntington formations of northern Indiana.

The cephalopods found in the Bouleaux formation are not significant for purposes of correlation. The *Gasconsoceras* referred tentatively to *Gasconsoceras obesum* indicates merely that this genus continues upward from the Gascons into the Bouleaux formation.

*Gaspocyrtoceras cooperi*, from the West Point formation, appears closely related to *Gaspocyrtoceras telleri* from the Racine of Wisconsin.

The generic relationship of *Periodanoceras* (?) *chaleureuse*, from the Indian Point formation, to the genotype *Periodanoceras rotundatum* Foerste is extremely doubtful in the absence of adequate knowledge of the structure of the siphuncle of this genotype.

Fortunately, the studies of Prof. Stuart A. Northrop on the remaining fauna of the Port Byron area, supply additional information of value for purposes of correlation. These studies are based chiefly on the brachiopods along with a few corals, an occasional trilobite, etc., and the following data have been kindly supplied by him to the present writer.

Clemville: 9 identities with Lower Clinton.

La Vieille: 13 identities with Upper Clinton.

Gascons: little of diagnostic value, except *Conchidium knighti* which occurs in higher Wenlock and Aymestry.

Bouleaux: 12 identities with Waldron; 11 identities with Racine.

West Point: 15 identities with Louisville; 15 with Brownsport; 12 with Racine.

Indian Point: nothing diagnostic.

These observations definitely place the Clemville formation in the Lower Clinton and the La Vieille formation in the Upper Clinton. Moreover, they definitely indicate the reference of the Bouleaux and the West Point to the Lockport group of formations. The *Conchidium* in the Gascons also suggests Lockport relationship.

This does not mean necessarily that the Gascons is to be correlated definitely as Racine and that the Bouleaux and West Point formations are at a higher horizon than the Racine, but that the sequence Gascons—Bouleaux—West Point corresponds in a general way to the sequence included in the Lockport group of more western areas. The correlation of the Indian Point formation, for the present can be left in doubt, but there is nothing in its cephalopod fauna which does not permit its reference to the Lockport as well.

Of course, as far as the cephalopod fauna is concerned, there are no identities of species between the cephalopods of the Port Daniel Silurian fauna and any other Silurian fauna farther west, so that the relationship is not very close, as far as this part of the Port Daniel fauna is concerned. The nearest approach to identity is that shown by *Bickmorites americanus* and *Bickmorites barbensis* with *Bickmorites bickmoreanus* as mentioned above.

As to European affinities, there is no satisfactory evidence of such relationship among the cephalopods beyond that shown by other Lockport faunas farther west. The reference of *Calocyrtoceras bouleauxense* to a genus founded on a Bohemian species is not sufficient evidence of close relationship. In a similar manner, the nodose ornamentation of *Dartoceras nodosum* does not indicate close relationship to such genera as *Ptenoceras*, *Trochoceras*, *Ptyssoceras*, or *Hercoceras*, all of which are more or less depressed conchs.



The present study of the Silurian cephalopods of the Port Daniel area can be considered only as preliminary. Most of these cephalopods occur in sandstone, and, although this sandstone often is finegrained, it frequently fails to preserve the surface ornamentation satisfactorily. Many of the specimens are distorted sufficiently by pressure after the death of the animal to make their original cross section only approximately determinable. Frequently not even the location of the siphuncle is known definitely and the structure of its segments rarely is preserved. The septa rarely are preserved except along their sutures. The outlines of the apertures of such genera as *Mandaloceras*, *Hexameroceras*, and *Phragmoceras* are too imperfectly preserved to admit of close comparison with species known from other areas, though their approximate form may be known. Future discoveries will, no doubt, supplement our knowledge greatly.

Access to the cephalopods of the Port Daniel area preserved in the collections of Peabody Museum at Yale University and in the National Museum of Canada was made possible by the generosity of Prof. Stuart A. Northrop, who already was engaged on a detailed study of the entire Silurian fauna from this area, before he learned of the desire of the present writer to study the cephalopods. At a later date the cephalopods collected subsequently by Dr. G. Arthur Cooper, of the U. S. National Museum, also became available. To both of these the present writer expresses here his deep appreciation of the favors received.

For stratigraphic and lithologic information and for a geologic map of the Port Daniel area consult the report on the Stratigraphy of the Port Daniel-Gascons area of Southeastern Quebec, by Charles Schuchert and J. Doris Dart, in Bulletin 44 of the Geological Survey of Canada, 35-58 (1926).

#### 1. *Orthoceras clemvillense* new species

Plate XVII, figs. 1A, B; 2

Specimen 125 mm. long, its lateral diameter enlarging from 53 mm. to 70 mm. within a length of 110 mm., indicating an angle of enlargement of 9 degrees. The corresponding dorsoventral diameters are 50 mm. and 57 mm. The number of camerae within

a length equal to the lateral diameter of the conch is 9. The sutures of the septa are directly transverse. The concavity of the septa equals 14 mm. The siphuncle is 9 mm. in diameter where the dorsoventral diameter of the conch is 57 mm., and its center is 23 mm. from the ventral wall of the conch. At the septal necks it is constricted to 5 mm. Here the inner margin of the septa curves diagonally downward to a moderate extent, without reaching a vertical direction. The connecting rings are more distinctly convex ventrally than dorsally, and their lower face on this side is adnate to the upper surface of the underlying septa for a width of 2 to 3 mm. Along the dorsal side of the siphuncle there is no corresponding adnation. On both sides of the siphuncle the connecting rings appear attached to the extreme inner part of the lower surface of the overlying septa. The general form of the segments of the siphuncle is obliquely globular, but truncated at top and bottom. The surface of the shell apparently was smooth. Plate XVII, figs. 1A, B.

Occurrence: Clemville, near Port Daniel; in the Clemville formation. Holotype; cat. no. 12704, Peabody Museum, Yale University.

Remarks.—This specimen is referred to the genus *Orthoceras*, because it is not referable to any one of the genera established by Hyatt and others in subdividing that genus. The adnation of the lower face of the ventral side of the connecting rings to the adjacent part of the septa is a feature not observed in other orthoceroids so far. Otherwise, this specimen closely resembles those species, usually referred to *Orthoceras*, in which the connecting rings distinctly enlarge within the camerae, but in which no recurving brim is shown by the septal necks, and in which the interior of the siphuncle is not lined with calcareous deposits.

A somewhat similar, but smaller specimen is 40 mm. long and 39 mm. in diameter. It includes only 7 camerae, but with lengths indicating that originally 8 camerae occurred in a length equal to the diameter of the conch. The concavity of the septa equals 12 mm. The location of the siphuncle is central, the maximum diameter of its segments is 5.6 mm., and its septal necks contract to 4 mm. The inner margins of the septa curve diagonally

downward as in the holotype just described, but there is no area of adnation along the lower face of the immediately overlying connecting rings. Possibly the conch has been sectioned in a lateral direction, but there is no evidence of this. Found at Little Port Daniel river; in the *Hyattidina* zone of the Clemville formation. Cat. no. 12705, Peabody Museum, Yale University. Plate XVII, fig. 2.

## 2. *Orthoceras chaleurense* new species

Plate V, fig. 2

Specimen 120 mm. long, the living chamber occupying 60 mm. of this length. Its larger diameter enlarges from 27 mm. at its base to 33.5 mm. at the base of the living chamber, and to 35 mm. at the top of the latter. The conch appears to have been flattened at right angles to these diameters by pressure after the death of the animal. In its present condition, the shorter diameter at the base of its living chamber is 30 mm. The number of camerae in a length equal to the larger diameter of the conch increases from 7 along the lower half of the phragmacone to 7.5 farther up. The sutures of the septa are directly transverse. The septa are moderately concave. The location of the siphuncle and the character of the surface of the shell are unknown.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype, cat. no. 6804, National Museum of Canada.

Remarks.—This species is referred to *Orthoceras* chiefly because the details of its structure are not known sufficiently well to determine whether it is referable to any one of the genera into which *Orthoceras* was divided by Hyatt and other authors.

## GEISONOCERINA Foerste

Genotype: *Orthoceras wauwatosense* (Whitfield). Geol. Wisconsin, vol. 4, 297, pl. 19, fig. 2; *Geisonoceras wauwatosense* Foerste, Denison Univ. Bull., Jour. Sci. Labs., 23, 250, pl. 53, figs. 2A-D, 3 (1928).

Conchs differing from typical *Geisonoceras* in being ornamented by numerous, close, raised, transverse lines or striae, instead of comparatively broad bands. The grouping of species under these

two terms, *Geisonoceras* and *Geisonocerina*, presents difficulties in the case of intermediate forms, though readily distinguishable in the majority of cases.

3. *Geisonocerina* (?) *danielensis* new species

*Plate V, fig. 1*

Specimen 144 mm. long, enlarging at an angle of 10 degrees from a diameter of 20 mm. at its base to 38.5 mm. at a point 105 mm. farther up, and then contracting to 35 mm. at its top, only the phragmacone being preserved. This contraction of the upper part of the phragmacone is anomalous. About 3.5 camerae occupy a length equal to the diameter of the conch. The sutures of the septa are directly transverse. The septum at the top of the specimen has a concavity of 6 mm. The location of the siphuncle is central, and its diameter is 6 mm. where that of the conch is 37 mm. Apparently it enlarges only slightly within the camerae, if at all. There are no traces of surface markings on the shell except along the upper 20 mm. of its length, where relatively weak transverse striations occur at the rate of 5 in a length of 2 or 3 mm. It is assumed that the lower part of the shell was similarly striated.

Occurrence: Middle branch of Port Daniel river; in the Ordovician Mictaw shales. Holotype; cat. no. 12775, Peabody Museum, Yale University.

4. *Geisonocerina barbensis* new species

*Plate IV, figs. 1, 2; plate V, fig. 3*

Living chamber 170 mm. long, enlarging at an angle of 6 degrees from a diameter of 45 mm. at its base to 62 mm. at its top. The suture of the septum at its base is directly transverse, and the concavity of this septum is 14 mm. The location of the siphuncle apparently is central, but it is poorly indicated. Faint traces of transverse striae are present along the upper part of the specimen, which is a cast of the interior of the chamber, but these are more numerous than in typical *Geisonoceras*. National Museum of Canada, cat. no. 6805. *Plate IV, fig. 1*.

A second specimen, 150 mm. long, enlarges at an angle of 6 degrees from a diameter of 37 mm. at its base to 45 mm. at a point 90 mm. farther up. Of the two camera at its base the upper one has a length of 12 mm. and the lower one a length of 13 mm., suggesting 3 camerae in a length equal to the diameter of the conch. The concavity of the septum at its base is 11 mm., and the location of the siphuncle apparently was central. Such traces of transverse markings as can be detected are vague, but these markings are more numerous than in typical *Geisonoceras*. Peabody Museum, Yale University, cat. no. 12751. Plate IV, fig. 2.

Two other specimens from the same locality, but with apical angles of only 3 or 4 degrees, show 10 or 11 distinct transverse bands in a length of 11 mm. Peabody Museum, Yale University, cat. nos. 12719, and 12747.

Occurrence: Anse-à-la-Barbe, Port Daniel; specimen 12719 is from the Gascons formation; the other three are assumed to be also from the Gascons. The two specimens here described first, and figured on plate IV, are regarded as cotypes. The more distinctly banded specimens may belong to a distinct species, but this can not be determined from the material available for study.

A more distinctly banded appearance is presented by a specimen 153 mm. long, strongly flattened by pressure, and retaining 10 transverse bands in a length of 10 mm. where its maximum diameter is 37 mm. The banding in this case is similar to that of typical *Geisonoceras*, except that the number of these bands in a length equal to the diameter of the conch is relatively more numerous. From the highest point reached on Little Port Daniel river, either near the western end of range VIII of Port Daniel township, or possibly in the eastern part of Hope township; in the Gascons formation. Peabody Museum, Yale University, cat. no. 12715. Plate V, fig. 3.

Another banded specimen, cat. no. 12724, from the same museum, was found at the Black Capes, near Little Cascapedia river, in the middle of the Gascons formation.

5. *Geisonoceras* sp. (Indian Point)*Plate X, fig. 2*

Specimen apparently consisting of the lower part of a living chamber 36 mm. long, with a septum at its base, but with no distinct trace of the siphuncle. It enlarges apparently at an angle of 8 degrees, but is strongly flattened by pressure at right angles to its maximum diameter, which equals 20 mm. at 22 mm. above the suture of the septum at its base. There are 14 distinctly outlined bands in a length corresponding to this diameter. Originally these bands probably were directly transverse.

Occurrence: From the shore at Indian Point, Port Daniel; in the upper part of the Indian Point formation. Cat. no. 12769, Peabody Museum, Yale University.

Remarks.—This specimen is of interest chiefly because it represents a typical form of *Geisonoceras*, its transverse bands being broad, flat, and sharply outlined along their upper margins.

6. *Geisonoceras* (?) sp. (Anse-à-la-Barbe)*Plate X, fig. 5*

Specimen 70 mm. long, 33 mm. in diameter at its base, apparently with a trace of a septum at its lower end. Sutures of septa directly transverse. The lower 4 camerae occupy a length of 30 mm.; the overlying one is 6 mm. long, and this is followed by 3 camerae in a length of 22 mm. There is no trace of the siphuncle, nor is there any clear indication of the character of its surface markings.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Cat. no. 12746, Peabody Museum, Yale University.

Remarks.—The exact generic relationship of this specimen can not be determined. It probably was transversely banded, but it differs from the other specimens here referred to *Geisonoceras* by its extremely low rate of enlargement, no distinct difference in diameter being noted within the length preserved.



7. *Kionoceras barbense* new species*Plate XXIV, fig. 11*

The holotype is 64 mm. long, 21 mm. of this length apparently belonging to the living chamber. The rate of enlargement of the conch can not be determined with accuracy, owing to obvious distortion of the latter, but it appears to have been small. At the base of the living chamber its diameter at present is 21 mm. Six camerae occur in a length of 22 mm. near the top of the phragmacone, this series being overlaid apparently by a single camera 2.5 mm. long, and the latter by one 1 mm. long. The third septum from the top has a concavity of 4.5 mm. The location of the siphuncle is central and its diameter is 2.4 mm. The surface of the shell is vertically fluted, the intermediate vertical ribs numbering 48 within the circumference of the conch. The crests of these ribs are relatively narrow and between these crests there are traces of about 7 intermediate raised lines, apparently equal in size, and visible only under a lens. There are also traces of transverse lines. Where most distinctly defined these number 12 in a length of 5 mm. or 6 in a length of 2 mm., also visible only under a lens.

Occurrence: Near the mouth of the Anse-à-la-Barbe River, Port Daniel; from the Gascons formation. Holotype; U. S. National Museum, cat. no. 92789.

8. *Kionoceras bouleauxense* new species*Plate VII, figs. 4, 5*

Holotype 87 mm. long, its maximum diameter enlarging from an estimate of 48 mm. at its lower end to 59 mm. at a point 65 mm. farther up, indicating an angle of enlargement of 9 degrees. The minimum diameter at the base of the specimen is 41 mm., but this is due to pressure after the death of the animal. At the lower end of the specimen there are two camerae, of which the lower one is 7 mm. long, and the upper one is 8 mm. From this it is estimated that about 6 camerae occupied a length equal to the diameter of the conch. The concavity of the septum at its base is 14 mm. The siphuncle is not preserved. The surface of

the specimen was ornamented by 31 or 32 vertical primary ribs, and an equal number of much less prominent secondary ribs, the crests of both being sharply angular. In addition there are low transverse wrinkles, from 8 to 9 in a length of 20 mm. Cat. no. 12733. Plate VII, fig. 4.

A similar specimen, 80 mm. long, has a maximum diameter of 67 mm. at a point 48 mm. above its base. The lower 4 camerae have a length of 36 mm., the uppermost, or fifth camera being 6 mm. long. Apparently the conch was fully mature. Apparently 7.5 camerae occurred in a length equal to its maximum diameter. About 31 primary vertical ribs occupied its circumference, alternating with an equal number of secondary ones, both with narrowly angular crests. About 9 low transverse wrinkles occur in a length of 20 mm. The passage of the siphuncle through the septum at its base is 6.5 mm. in diameter. Cat. no. 12731. Plate VII, fig. 5.

Occurrence: Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Peabody Museum, Yale University. The two specimens here figured are cotypes.

#### 9. *Kionoceras* sp. (Bouleaux)

##### *Plate VII, fig. 6*

Specimen 90 mm. long, strongly flattened by pressure, with a maximum width of 70 mm. at a point 5 mm. above the base of the living chamber, in the present condition of the specimen, its original diameter probably being between 5 and 10 mm. greater. From the present divergence of the vertical ribs on the surface of the specimen it is estimated that its original angle of enlargement was about 7.5 degrees. Only one camera remains attached to the base of the living chamber, and this is 10 mm. long, the septum at its base having a concavity of 20 mm. Within the width of the specimen there are 16 primary vertical ribs alternating with an equal number of secondary ones, but the secondary ones are almost as prominent as the primary ones. There are faint traces of numerous transverse striae, not sufficiently distinct to be counted with accuracy, but estimated at 5 in a length of 2 mm. There are no conspicuous transverse wrinkles.

Occurrence: Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Cat. no. 12728, Peabody Museum, Yale University.

Remarks.—This specimen is characterized by the almost equal prominence of the secondary vertical ribs compared with the primary ones. In other respects it resembles *Kionoceras bouleauxense*, of which it may be a minor variation.

10. *Protokionoceras perstrigatum* new species

Plate XXIII, fig. 1

The holotype is 160 mm. long, 90 mm. of this length apparently belonging to the living chamber. In its present flattened condition its maximum diameter enlarges from 54 mm. at the base of the specimen to 66 mm. at a point 95 mm. farther up. At the upper point the corresponding shorter diameter in the present condition of the specimen is 43 mm. The lower 3 camerae, in ascending order, have lengths of 16, 17, and 18 mm. respectively, the conch not having attained its gerontic stage of growth. The sutures of the septa are straight and probably were directly transverse to the length of the conch. The concavity of the septa is 11 or 12 mm. There is no distinct trace of the siphuncle. The surface of the shell is ornamented with numerous vertical ribs. Of the more prominent ribs, here called primary, there are about 18 within the circumference of the conch. Where least disturbed by compression these primary ribs are 11.5 mm. apart. The intervening spaces are not concave, but convex. Midway between these primary ribs there is a single secondary one, and intermediate between the primary and secondary ribs there are either 2 or 3 tertiary ones. The secondary and tertiary ribs are subequal in size. In addition to the series of ribs already mentioned there is a quaternary series, occurring singly where the spaces between the preceding series admit their development. The general effect produced is that of widely spaced primary ribs of slight prominence alternating with groups of 5 or 6 subequal ones, the still finer ribs being relatively inconspicuous. Transverse lines are present, but these are very fine and numerous and not readily detected except under a lens.

Occurrence: Near the mouth of Anse-à-la-Barbe River, Port

Daniel; from the Gascons formation. Holotype; U. S. National Museum, cat. no. 92790.

11. *Protokionoceras imperator* new species

*Plate VIII, figs. 1, 2; plate IX, fig. 1*

Specimen 525 mm. long, enlarging at an angle of 9.5 degrees from a maximum diameter of 55 mm. at its base to 100 mm. at a point 275 mm. farther up, where the base of the living chamber is located. At 125 mm. above this base of the chamber the diameter of the specimen has increased to 118 mm. Apparently the upper part of the living chamber contracts slightly, but this part is too poorly preserved to make accurate measurement possible. The specimen was flattened by pressure after the death of the animal. Where its present maximum diameter is 112 mm., its minimum one is 91 mm. The number of camerae in a length equal to the maximum diameter increases from 4 along its lower part to 5 at the top of the phragmacone. The sutures of the septa are moderately oblique in the present condition of the specimen. The concavity of the septum at its base equals 13 mm. Along the upper two-thirds of the length of the specimen the vertical ribs are relatively equal in size. Ten occur in a width of 20 mm. where the maximum diameter of the specimen is 110 mm. Where this diameter is 78 mm., 10 vertical ribs occupy a width of only 16 mm. Toward the lower end of the specimen there are moderate differences in the prominence between the primary and secondary ribs. Both are so much narrower here than farther up that they resemble strongly raised vertical lines or striae, rather than ribs. Of the larger or primary striae there are between 18 and 20 within the circumference of the conch. Alternating with the primary striae are an equal number of secondary ones, double this number of tertiary ones, and four times this number of quaternary ones. There are no conspicuous transverse markings. Holotype.

If an additional fragment, 170 mm. long and 110 mm. in diameter at its upper end, belongs to the same specimen, then the upper part of the living chamber certainly contracts toward its

aperture. But this additional fragment does not actually fit the top of the large specimen described above, and there is no definite information on the label that it ever was part of the latter.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 6818, National Museum of Canada.

Remarks.—Among described forms, this species resembles most closely the *Protokionoceras medullare* (Hall), from the Racine of Wisconsin and Illinois, from which it differs chiefly in the absence of distinct transverse markings.

## 12. *Protokionoceras microlineatum* new species

*Plate VII, figs. 1, 2, 3*

Specimen 35 mm. long and 30 mm. wide at its top, with two distinct sutures of septa 13 mm. apart, suggesting that only 2.3 camerae occurred in a length equal to the diameter of the conch. The conch has been strongly flattened by pressure after the death of the animal. In its present condition it appears to enlarge at an angle of 10 degrees. Its surface is marked by 40 narrow primary vertical ribs, alternating with 40 less prominent secondary ones, these two sets alternating with 80 still finer tertiary ones. In addition, there are numerous very minute transverse striae, sharply defined when examined under a lens, of which 10 occur in a length of 1 mm.

Occurrence: From the shore at Indian Point, Port Daniel; in the upper portion of the Indian Point formation. Holotype; cat. no. 12768A, Peabody Museum, Yale University. Plate VII, fig. 1.

Two fragments from the same locality and horizon, but evidently from larger parts of conchs, represented by figures 2 and 3 on the same plate, may belong to the same species. Of these, the first (Plate VII, fig. 2) shows poor traces of numerous transverse striae, but the second (Plate VII, fig. 3) does not. Cat. no. 12768B, Peabody Museum; and cat. no. 6806, National Museum of Canada, respectively.

13. *Spyroceras* sp. (Clemville)*Plate VI, fig. 4*

Conch 18 mm. long and 9 mm. wide, with 6 annulations in a length corresponding to this width. The annulations are distinctly defined, and they are 0.6 mm. wide where the width of the intervening grooves is almost 1.5 mm.

Occurrence: Road cut at the old lime kiln near Clemville, Port Danville; from the Clemville formation. Peabody Museum, Yale University, cat. no. 12701.

Remarks.—This specimen resembles *Spyroceras orientale* from the Indian Point formation, but the annulations appear more numerous and more prominent. Unfortunately the surface ornamentation is poorly preserved.

14. *Spyroceras barbense* new species*Plate XXIII, figs. 5, 6*

The holotype is 66 mm. long, 40 mm. of this length belonging to the living chamber. The conch was compressed by pressure after the death of the animal. In its present condition its maximum diameter increases from 17.5 mm. at its base to 24 mm. at a point 50 mm. farther up. At the upper point its shorter diameter is 17 mm. At the base of the specimen 3 camerae occur in a length of 18 mm. The sutures of the septa slope downward in a direction assumed to be ventral. The concavity of the lowermost septum is about 3.5 mm. The passage of the siphuncle through this septum is 1.5 mm. and its location is central. The surface of the shell is crossed by numerous transverse annulations which are crossed by the sutures of the septa diagonally, but the original slope of the latter can not be determined on account of the dorsoventral compression of the conch. Where the diameter of the conch is 19 mm. there are 16 annulations in a length of 19.5 mm. At a diameter of 23 mm. there are 17 annulations in a corresponding length. Farther up the annulations become more crowded, numbering 7 in a length of 7 mm. The annulations are of small elevation, possibly rising scarcely one fifth of a millimeter, but their crests are relatively narrow and distinct, much



narrower than the intervening grooves. Locally there are traces of vertical striae, too poorly preserved to admit of exact counting and visible only under a lens. The stronger striae appear to number about 5 in a width of 2 mm. with 2 or 3 finer striae in the intermediate spaces, both being poorly defined. Cat. no. 92791. Plate XXIII, fig. 5.

A second specimen, 50 mm. long, shows similar annulations. It agrees with the holotype also in enlarging more rapidly along its lower half than farther up. In its present compressed condition its maximum diameter enlarges from 14.5 mm. at a point 12 mm. above its base to 17.7 mm. at a point 15 mm. farther up, and to 20 mm. at a point 16 mm. farther than the last point of measurement. Along the whole length of the specimen 7 annulations occur in a length of 10 mm. The crests of the annulations are equally narrow as in the holotype. There are traces of transverse lines and also of vertical ones, the latter appearing somewhat coarser than in the preceding specimen. Cat. no. 92791A. Plate XXIII, fig. 6.

Occurrence: Near the mouth of Anse-à-la-Barbe River, Port Daniel; from the Gascons formation. U. S. National Museum, cat. nos. 92791 and 92791A.

15. *Spyroceras* sp. (Morrin)

Plate VI, fig. 3

Specimen 30 mm. long, enlarging at an angle of 10 degrees from a diameter of 16 mm. at its base. About 7 annulations occur in a length equal to the estimated diameter of the specimen at its top. Along the upper part of the specimen there are 9 vertical striae within a width of 5 mm., the alternate striae of this series being slightly larger. There also are traces of very fine and numerous transverse striae.

Occurrence: Morrin road, Gascons; in the Gascons formation. Cat. no. 12717, Peabody Museum, Yale University.

Remarks.—This fragment evidently belongs to the group of species typified by *Spyroceras bilineatum* (Hall), from the Trenton, but not enough is known about either to discriminate them well.

16. *Spyroceras* sp. (Anse-à-la-Barbe)*Plate XXIII, fig. 2*

Fragment of a conch 35 mm. long; strongly compressed after the death of the animal, its present maximum diameter enlarging from an estimated width of 14 mm. near its lower end to 16 mm. at a point 16 mm. farther up. At the upper point there are 7 annulations in a length of 15 mm. Their crests rise 0.7 mm. above the intervening grooves. These crests are rounded but much narrower than the grooves. The vertical ribs are alternately stronger and weaker, but are distinct only laterally where the ribs are known to be crowded owing to compression of the conch. The stronger striae are estimated to have occurred at the rate of about 10 in a width of 10 mm. where the diameter of the conch is 16 mm.

Occurrence: Anse-à-la-Barbe River, Port Daniel; from the Gascons formation. U. S. National Museum, cat. no. 92792.

17. *Spyroceras chaleurense* new species*Plate VI, figs. 5A, B*

Specimen 18 mm. long, 10 mm. wide, with 9 annulations in a length corresponding to this width. The annulations are sharply defined from the intervening grooves, and are of about the same width in a vertical direction as the latter. The number of vertical striae in a width of 1 mm. varies from 5 to 7. From 13 to 15 transverse striae occur in a length of 1 mm., but are not as conspicuous as the vertical ones.

Occurrence: Reddish Point ridge, Gascons; in the West Point formation. Holotype; cat. no. 12761, Peabody Museum, Yale University.

Remarks.—Compared with *Spyroceras chicottense* Foerste, from the Chicotte formation of Anticosti, the annulations and vertical striae are equally numerous, but the transverse striae are fully twice as numerous as in the latter, and are less conspicuous than the vertical ones, while in the Anticosti species both sets of striae are weakly defined, though it is the vertical ones which are the most difficult to detect.

18. *Spyroceras danielense* new species*Plate XIX, figs. 2A, B*

Specimen 25 mm. long, 11 mm. wide, with 6 annulations in a length corresponding to this diameter. Only the transverse striae are seen readily under a lens, and these number 6 or 7 in a length of 1 mm. The vertical striae are too indistinctly preserved to admit of accurate counting, but they appear to number about 5 in a width of 1 mm.

Occurrence: Indian Point, Port Daniel; in the Indian Point formation. Holotype; cat. no. 6808, National Museum of Canada.

Remarks.—Compared with *Spyroceras chicottense* Foerste, from the Chicotte formation of Anticosti, the annulations are relatively less numerous, and the transverse striae are more distinct, though minute.

19. *Spyroceras orientale* new species*Plate VI, fig. 2; plate XIII, fig. 3*

Specimen 18 mm. long, 8 mm. in diameter, with 4.5 annulations within a length corresponding to this width. The width of the annulations is slightly more than a third of that of the intervening grooves, the latter being only moderately concave. The vertical striae are sharply defined, 5 to 6 occurring in a width of 1 mm.

Occurrence: Indian Point, Port Daniel; from the Indian Point formation. Holotype; National Museum of Canada, cat. no. 6807.

20. *Spyroceras northropi* new species*Plate VI, fig. 1*

Specimen 20 mm. long, at present represented by an impression of its surface 7 mm. wide, but originally nearer 9 mm. in diameter. Eight annulations occur in a length of 9 mm. The width of these annulations, in a vertical direction, equals about one-third of that of the intervening grooves, the latter being of moderate depth. The vertical striae are distinct; about 5.5 occur in a width of 1

mm. Apparently there are also very faint transverse striae, about 10 in a length of 1 mm.

Occurrence: From the shore at Indian Point, Port Daniel; in the Indian Point formation. Holotype; cat. no. 12772, Peabody Museum, Yale University. Named in honor of Stuart A. Northrop.

Remarks.—This species differs from *Spyroceras orientale*, described next, chiefly in its more numerous annulations.

21. *Dawsonoceras* sp. (Anse-à-la-Barbe)

*Plate IX, fig. 3*

Conch 330 mm. long. At 95 mm. above its base its maximum diameter in its present condition is 42.5 mm., enlarging to 53 mm. at a point 170 mm. farther up. At a diameter of 46 mm. there are 6 annulations in a length of 45 mm. At a diameter of 53 mm. there are 6 annulations in a length of 51 mm. At the upper point these annulations rise fully 2 mm. above the intervening grooves. The annulations are directly transverse on the side preserved. Their crests are rounded and about as wide as the intervening grooves. There are traces of undulating transverse raised lines, as in typical *Dawsonoceras*, but too indistinct for definite measurement. Cat. no. 92793. Plate IX, fig. 3.

A second specimen is 265 mm. long and enlarges from a diameter of 52.5 mm. at a point 40 mm. above its base to 69.5 mm. at a point 190 mm. farther up. At the upper point there are 7 annulations in a length of 68 mm. In this specimen the transverse raised undulating lines are much better defined, 6 occurring in a length of 5 mm. along the upper end of the specimen. There is evidence of their undulation. Locally this resembles that of the transverse striae in *Dawsonoceras granti* Foerste, described in volume 23 of this Bulletin in 1928, but their preservation is not sufficiently clear for photography or accurate description. Cat. no. 92793A.

Occurrence: Near the mouth of Anse-à-la-Barbe River, Port Daniel; from the Gascons formation. U. S. National Museum, cat. nos. 92793, and 92793A.

22. *Cycloceras* (?) *gaspense* new species*Plate X, fig. 1*

Specimen 120 mm. long, only the phragmacone being preserved. It enlarges at an angle of 5.5 degrees from a dorsoventral diameter of 23 mm. at its base to 31 mm. at a point 85 mm. farther up. At a level of 95 mm. above the base of the specimen the conch suddenly contracts to a diameter of 28 mm. and retains this diameter for a length of at least 25 mm. This appearance is anomalous and can not be explained from the single specimen at hand. Where the dorsoventral diameter of the conch is 31 mm., its lateral diameter is estimated at 26 mm., the conch having been compressed by pressure subsequent to the death of the animal. The number of camerae in a length equal to the dorsoventral diameter of the conch is 3. The sutures of the septa are straight, but slope downward in a ventrad direction at an angle of 8 to 10 degrees with the horizontal. The location of the siphuncle is central. There are vague traces of transverse annulations which slope downward in a ventrad direction at a slightly greater angle than the sutures of the septa, forming an angle of about 5 degrees with the latter. These annulations are almost obsolete, about 4 occupying a length of 10 mm.

Occurrence: From the shore at Indian Point, Port Daniel; in the Indian Point formation. Holotype, cat. no. 12766, Peabody Museum, Yale University.

Remarks.—This species resembles *Cycloceras niagarens* in the obliquity of the sutures of its septa, but differs from the latter in its somewhat shorter camerae. Both species belong to a group of orthoceroids in which the annulations are very low, and from which the character of the finer ornamentation of the surface of the shell is unknown, so that it is doubtful if this surface ever was striated transversely, or in any other direction. Possibly they belong to *Leurocycloceras*.

**LEUROCYCLOCERAS** Foerste

Genotype: *Leurocycloceras raymondi* Foerste. Denison Univ. Bull., Jour. Sci. Labs., vol. 23, p. 272, pl. 57, figs. 4A-C; pl. 56, figs. 5A, B (1928).

Conchs having the surface of the shell annulated as in *Cycloceras*, but not striated transversely as in that genus.

The various species of annulated orthoconic conchs referred to *Cycloceras* in the publication cited above agree in failing to show transverse striae parallel to the annulations. Unfortunately the surfaces of their shells are too poorly preserved to establish the absence of transverse striae even in well preserved specimens. Until the presence or absence of transverse striae on the surface of the shell of these species is definitely known, their generic reference must remain uncertain. In the mean time it is interesting to note the relatively frequent occurrence of such specimens in Silurian strata.

#### RIZOCERAS Hyatt

Genotype: *Orthoceras indocile* Barrande. Système silurien du centre de la Bohême, vol. 2, pt. 3, 57, pl. 185, figs. 1-6 (1874).

Also Foerste, Denison Univ. Bull., Jour. Sci. Labs., 21, 315, pl. 34, figs. 3A-E (1926).

Conchs enlarging rapidly, nearly straight except at their apical ends which may be slightly curved. The transverse striae on the surface of the shell curve downward both dorsally and ventrally, but the downward curvature on the antisiphonal side extends across the entire width of the conch while that of the siphonal side is distinctly narrower, and is regarded as locating the hyponomic sinus. The conch is compressed laterally. The sutures of the septa are directly transverse. The siphuncle is located near the ventral wall of the conch. Its segments are somewhat fusiform, being larger near the top, and contracting at the septal necks to less than half their diameter within the camerae. Middle Silurian of Bohemia.

It is doubtful whether any of the Gascons species here referred to *Rizoceras* actually belong to that genus. They resemble that genus only in the rapid enlargement of their conchs. Only in *Rizoceras* (?) *atlanticum* and *Rizoceras* (?) *pocilliforme* is there any indication of the former presence of a hyponomic sinus. In none of the specimens is there any indication of the siphuncle and nothing is known of its structure. Hence, the reference of these



species to *Rizoceras* is only tentative. Apparently the Gascons species have no close relationship to any genus known at present, but not enough is known of their structure to warrant the erection of a new generic name.

23. *Rizoceras* (?) *dartae* new species

*Plate X, fig. 3*

Specimen 120 mm. long, of which length 35 mm. belongs to the living chamber. The conch is relatively straight and erect. That one of its outlines which is assumed to be ventral is straight for a length of 55 mm., and then has a radius of convex curvature of 200 mm. for a length of 45 mm., above which the outline is relatively straight again. Its dorsal outline originally may have been straight along the entire length of the phragmacone, with possibly a slight concavity along its apical end, but at present it is protuberant between 25 and 70 mm. above the base of the specimen, its maximum protuberance being at 40 mm. above this base. This protuberance appears to be due to somewhat irregular lateral compression of the conch after the death of the animal. If this dorsal outline be assumed to have been originally almost straight then the original angle of enlargement of the conch in a dorsoventral direction was approximately 24 degrees for a length of nearly 60 mm., diminishing to 9 degrees farther up. At the base of the living chamber its dorsoventral diameter is 37 mm., its corresponding lateral diameter, in the present compressed condition of the conch, being 26 mm. The number of camerae in a length equal to the dorsoventral diameter increases from 8 at its lower end to 10 at midlength, and to 13 along the upper part of the phragmacone. The sutures of the septa are straight but rise in a ventrad direction at an angle of 9 degrees with the horizontal. The siphuncle is not preserved but is assumed to have been located along the convexly curved outline of the conch. There are faint traces of transverse lines along the living chamber, approximately parallel to the suture of the septum at the base of this chamber, but they are too vague to be counted with accuracy.

Occurrence.—Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 6809, National Museum of Canada. Named in honor of Jennie Doris Dart.

Remarks: This species is characterized by its slender and erect form, and the moderate rise of the straight sutures of its septa in a ventrad direction.

24. *Rizoceras* (?) *atlanticum* new species

*Plate X, fig. 6*

Specimen apparently a living chamber, 47 mm. long, the angle of enlargement of all except its basal part being 20 degrees. At its top it attains a diameter of 46 mm. Its lower part, for a length of 10 mm., is somewhat rounded, as though molded over the lower side of a septum. The specimen is strongly flattened at right angles to its plane of maximum enlargement, the shorter diameter at its top being estimated at 30 mm. Its surface is crossed by conspicuous transverse bands, 5 bands occurring in a length of 12 mm. at mid-height. These bands resemble those of typical *Geisonoceras*. Along one of the narrow sides of the specimen these bands curve narrowly downward as though locating a hyponomic sinus. However, there is no trace of the siphuncle.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype, Peabody Museum, Yale University; cat. no. 12741.

Remarks.—This species is characterized by its rapid rate of enlargement, and by its conspicuous transverse banding. The downward curvature of the transverse bands along one of its narrower sides appears to locate its ventral side.

25. *Rizoceras* (?) *pocilliforme* new species

*Plate XXIII, fig. 4*

The holotype is 55 mm. long, 31 mm. of this length belonging to the living chamber. At the base of the living chamber its maximum diameter is 38 mm. and the minimum one is 29.5 mm. At its top the corresponding diameters are 47 mm. and 35 mm. At 15 mm. beneath the base of the living chamber these diameters are estimated at 29.5 mm. and 24 mm. Along the phragmacone the maximum enlargement of the conch is at an angle of 30 degrees. Along the lower half of the living chamber this rate of

enlargement becomes distinctly less, the vertical outlines being slightly convex both along the longer and shorter diameters of this chamber. Along the upper half of the living chamber the vertical outlines are faintly concave, flaring slightly toward the aperture. Six camerae are preserved immediately beneath the living chamber, the upper 4 occupying a length of 10 mm., all of about the same length. The uppermost septum is exposed sufficiently to indicate that its concavity equalled at least 7 or 8 mm. The sutures of the septa are directly transverse. The surface of the conch is crossed transversely by distinctly raised lines occurring at irregular intervals. Along the phragmacone these intervals vary from 1.7 mm. to 4 mm. in length. At the base of the living chamber their length varies between 2.5 mm. and 3.7 mm. Along the middle of the chamber their length varies between 4.2 mm. and 4.7 mm. Toward its top some of the intervals are equally long. In addition to these more prominent raised lines there are faint traces of more closely crowded transverse ones, about 7 or 8 in a length of 5 mm. The convex surface at the base of the specimen appears to be formed by a poorly preserved septum. Along one of the more narrowly rounded sides of the conch the more prominent raised lines curve slightly downward along a width of 8 or 10 mm., thus forming very acute angles with the directly transverse sutures of the septa. This downward curvature of the raised lines is supposed to indicate the presence of a hyponomic sinus, suggesting that the siphuncle was nearer this side of the conch, though no trace of the siphuncle remains.

Occurrence: Near the mouth of Anse-à-la-Barbe river, Port Daniel; from the Gascons formation. U. S. National Museum, cat no. 92794.

26. *Rizoceras* (?) *infundibuliforme* new species

*Plate XXIII, fig. 3*

The holotype is 27 mm. long, 17 mm. of this length belonging to the living chamber. The maximum diameter of this chamber enlarges from 15 mm. at its base to 24.5 mm. at its top, its angle of enlargement in this direction being 39 degrees. The specimen

is compressed at right angles to these larger dimensions, the shorter diameter of its living chamber enlarging from 10 mm. at its base to approximately 19 mm. at its top, apparently owing to compression after the death of the animal. The uppermost camera apparently was nearly 3 mm. long, the next underlying one being 2 mm. long. The suture of the septum at the base of the living chamber is parallel to the margin of the aperture at its top. The uppermost septum is exposed for a length of nearly 5 mm. and appears to be nearly funnel-shaped with an angle of divergence of about 100 degrees. The location of the siphuncle is uncertain but apparently it was located at one of the more narrowly rounded sides of the conch. There are traces of transverse markings locally, but too poorly preserved for description.

Occurrence: Near the mouth of Anse-à-la-Barbe river, Port Daniel; from the Gascons formation. Holotype; U. S. National Museum, cat. no. 92795.

Remarks.—This specimen is of interest chiefly on account of the very rapid rate of enlargement of the conch.

#### CYRTORIZOCERAS Hyatt

Genotype: *Cyrtoceras minneapolis* Clarke, Geol. Minnesota, vol. 3, pt. 2, 808, pl. 59, figs. 1-6. See also Foerste, Denison Univ. Bull., Jour. Sci. Labs., 21, 316, pl. 35, figs. 3A-C (1926); *ibid.*, 27, pl. 29, figs. 4A-D; figs. 7A, B (1932); 28, 87. For generic description see Hyatt, in Zittel-Eastman, Text-Book of Paleontology, 529 (1900).

The original description of the genus *Cyrtorizoceras* by Hyatt is as follows:

Sections more compressed than in *Rizoceras*, living chamber shorter and apt to be more or less laterally compressed in gerontic stage, but the dorso-ventral diameters only very slightly so or not at all. Sutures more sinuous, and with decided ventral and dorsal saddles. Type *C. (Cyrt.) minneapolis*, Clarke sp. Ordovician and Silurian.

Neither *Rizoceras* nor *Cyrtorizoceras* contains vertical actiniform lamellae within its siphuncle.

Typical *Cyrtorizoceras* is known only from the Ordovician.

Bassler, in his Bibliographic Index of American Ordovician and Silurian Fossils, published in 1915, refers the species originally described by Hall under *Cyrtoceras dardanum* and *Cyrtoceras fosteri*, from the Racine of Wisconsin and Illinois, to *Cyrtorizoceras*, and Clarke and Ruedemann, in 1903 added a species from the Lower Shelby dolomite of the Lockport-Guelph at Shelby, New York, under the name *Cyrtorhizoceras curvicameratum*.

It is with these Silurian species, not with the Ordovician genotype, that the species from the Port Daniel area are most closely related.

27. *Cyrtorizoceras schucherti* new species

Plate XI, figs. 1A, B

Specimen 80 mm. long, of which length 30 mm. belongs to the living chamber. Moderately curved lengthwise, the radius of curvature of its convex ventral outline equalling 150 mm. The specimen enlarges dorsoventrally from a diameter of 28 mm. at its base to 41 mm. at the base of the living chamber, attaining 48 mm. at its aperture. The corresponding lateral diameters are 25 mm., 31 mm., and approximately 39 mm. The number of camerae within a length equal to the dorsoventral diameter of the conch is 11, when counted along its ventral outline. The sutures of the septa curve only slightly downward laterally but rise at an angle of 6 degrees above the horizontal in a ventrad direction near the top of the phragmacone, producing low saddles which tend to be somewhat angular along the median part of their ventral course. The siphuncle is not preserved, but its location evidently was ventral. The surface of the shell is crossed by transverse bands and striae which are almost directly transverse dorsally and laterally, but which curve downward distinctly along the median part of their ventral course, the width of this downward curvature equalling from 17 to 20 mm. along the upper part of the living chamber, while its depth equals 3 mm. Along the lower part of this chamber 4 transverse bands occupy a length of 5 mm., while at the lower end of the specimen 5 bands occur in the same length. Along the greater part of the length of the specimen 14 transverse striae occur in a length of 5 mm.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 12748, Peabody Museum, Yale University. Named in honor of Prof. Charles Schuchert.

Remarks.—This specimen is characterized by its moderate curvature, its numerous transverse striae, and the distinct downward curvature of its transverse bands and striae along former locations of the hyponomic sinus.

28. *Cyrtorizoceras diagonale* new species

*Plate XXV, figs. 5, 6*

The holotype is 71 mm. long, 23 mm. of this length belonging to the living chamber. The radius of curvature of its convex ventral outline increases from 60 mm. along its lower third to 90 mm. farther up. Its dorsoventral diameter enlarges from 25 mm. near its base to 38 mm. at the aperture which is 60 mm. farther up ventrally. In its present flattened condition its lateral diameter at the aperture is 25 mm. At the top of the phragmacone its dorsoventral diameter equals 33.5 mm. Ventrally there are 8.5 camerae in a corresponding length. The uppermost camera has a length of 3.4 mm., the two underlying camerae having a combined length of 9 mm., indicating that the conch had reached its gerontic stage of growth. The sutures of the septa curve only slightly downward laterally, but rise distinctly higher ventrally than dorsally. There is no trace of the siphuncle. The surface of the specimen is distinctly banded, 4 bands occurring in a length of 6 mm. at the top of the phragmacone ventrally, the underlying 4 having a length of 8.5 mm., beneath which they become shorter again. In addition there are fine raised lines, parallel to the transverse bands, about 5 lines in a length of 2 mm. At the top of the phragmacone these bands cross the sutures of the septa ventrolaterally at an angle of approximately 30 degrees, sloping downward in a ventrad direction. Along the ventral outline of the conch they curve distinctly downward for a width of near 10 mm. and a depth of nearly 2 mm., locating the hyponomic sinus. The siphuncle probably was located close to this ventral outline. Cat. no. 92796. Plate XXV, fig. 5.

A second specimen, 37 mm. long, consists of a living chamber,



with 2 camerae still attached. Its dorsoventral diameter at the base of the living chamber is 32.5 mm. The transverse banding is well shown. Cat. no. 92796 A. Plate XXV, fig. 6.

A third specimen is 63 mm. long, 30 mm. of this length dorso-laterally belonging to the living chamber. The specimen is distorted, but in its present condition its dorsoventral diameter at the base of the living chamber is 32.5 mm. The transverse banding and the raised lines cross the sutures of the septa as in the preceding specimens. Along the upper part of the phragmacone slightly more than 5 bands occur in a length of 10 mm. The raised lines here number 5 in a length of 2 mm. Cat. no. 92809.

Occurrence: Near the mouth of the Anse-à-la-Barbe River, in the Port Daniel area; from the Gascons formation.

Remarks—Compared with *Cyrtorizoceras schucherti* Foerste, the transverse bands slant much more strongly downward in a ventrad direction.

#### 29. *Cyrtorizoceras* sp. (Bouleaux)

Plate XI, fig. 2

Specimen 47 mm. long, of which length 27 mm. belongs to the living chamber. At the base of this chamber its dorsoventral diameter is estimated at 32 mm. The number of camerae occupying a length equal to this dorsoventral diameter is estimated at 11, when counted along its ventral outline. The sutures of the septa curve downward slightly dorsolaterally, rise ventrolaterally, and become horizontal or curve slightly downward ventrally. The surface of the specimen is crossed by broad bands of which 5 occupy a length of 16 mm. along its ventral side. These bands slope strongly downward in a ventrad direction, being relatively straight along the lateral part of their course.

Occurrence: Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Cat. no. 12732, Peabody Museum, Yale University.

Remarks—This specimen evidently is closely related to such species as *Cyrtorizoceras dardanum* and *Cyrtorizoceras fosteri*, both from the Racine of Illinois and Wisconsin, but it is not preserved well enough for accurate discrimination. It evidently is related also to *Cyrtorizoceras diagonale*, but its transverse bands are conspicuously wider.

30. *Cyrtorizoceras barbense* new species*Plate X, fig. 4*

Specimen 73 mm. long, of which length the living chamber occupies 38 mm. Ventral outline with a radius of convex curvature of 150 mm., but the cast of the interior of the living chamber is contracted between 5 and 13 mm. below the margin of its aperture both laterally and ventrally. The dorsal outline of the specimen is faintly concave, with a radius of curvature of 170 mm., along the phragmacone and the lower 10 mm. of the length of the living chamber, its general outline along this chamber being straight. At the base of the living chamber its dorsoventral diameter is 34 mm. and its lateral one is 28 mm. At the top of the living chamber its dorsoventral diameter is 39.5 mm., but its maximum lateral diameter appears to have been at 10 mm. above the base of this chamber, where it is estimated to have been 31.5 mm., apparently retaining this diameter as far as its aperture. The number of camerae in a length equal to the dorsoventral diameter of the conch is estimated at 11. The sutures of the septa are almost directly transverse at the top of the phragmacone, but slope slightly downward in a ventrad direction along the lower part of the specimen. The upper 2 camerae are distinctly shorter than those directly below, suggesting that the conch was fully mature. There are very faint traces of vertical ribs on the surface of this specimen, the latter being a cast of the interior of the conch.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 6810, National Museum of Canada.

Remarks.—Compared with *Cyrtorizoceras schucherti* Foerste, described on a preceding page, this specimen does not attain as large a size. Its dorsoventral diameter enlarges less rapidly, especially along the living chamber. It is less curved lengthwise. The sutures of its septa do not rise in a ventrad direction along the upper part of the phragmacone. Its living chamber is relatively taller.

Compared with *Rizoceras* (?) *dartae* Foerste, described on a preceding page, this specimen is more distinctly curved length-

wise, at least along its phragmacone, and the sutures of its septa do not rise distinctly in a ventrad direction.

Another specimen, from the same locality and horizon, represents an earlier stage of development. This specimen is 40 mm. long and enlarges dorsoventrally from 17 mm. at its base to 24.5 mm. at the base of the living chamber, and to 35 mm. at the aperture, the length of the living chamber being about 30 mm. The corresponding lateral diameters, in the present compressed condition of the conch, are 10.5 mm., 17 mm., and approximately 27 mm., the last diameter being estimated. The dorsal outline appears straight, in the relatively short length preserved. The ventral outline is faintly convex, as in the holotype. Five camerae occur in a length of 11.5 mm. ventrally. The sutures of the septa are virtually straight and at right angles to the curving ventral outline of the conch. The siphuncle is assumed to be nearly in contact with the ventral wall of the conch. U. S. National Museum, cat. no. 92810.

### 31. *Cyrtorizoceras gasconsense* new species

*Plate XXIV, fig. 6*

The holotype is 45 mm. long, the radius of curvature of its concave dorsal outline increasing from 25 mm. at the lower end of the specimen to 40 mm. at its top. The dorsoventral diameter of the conch increases from 10.6 mm. near its base to 14.5 mm. at midlength, and approximately to 18 mm. at its top. Where its dorsoventral diameter is 15.5 mm. its lateral one is 12.5 mm. The ventral side of the cross section is slightly more narrowly rounded than the dorsal one. The living chamber is about 25 mm. long. The upper 5 camerae are about 10 mm. long ventrally. The sutures of the septa curve distinctly downward laterally. The concavity of the septum at the base of the specimen is slightly over 1 mm. The siphuncle is close to the ventral wall of the conch. The thickness of the shell along the upper part of the conch is about half a millimeter, which is considerable, considering the size of the conch. The surface of the shell is transversely banded, 5 bands occurring in a length of 6.5 mm. ventrally. The bands are weakly defined and tend to be irregular

in width. These bands are directly transverse to the length of the conch along the dorsal half of the conch but curve slightly downward ventrally. There are also faint, minute, intermediate lines, parallel to the low bands.

Occurrence: At the Reddish Point, near Gascons Village, Port Daniel; in the West Point limestone. Holotype, U. S. National Museum, cat. no. 92797.

### **GASPOCYRTOCERAS** new genus

Genotype: *Gaspocyrtoceras cooperi* Foerste.

Conchs breviconic, curved, nearly circular in cross section, with the ventral side convex. Annulated, the annulations sloping slightly downward in a ventrad direction, with a shallow hyponomic sinus in the genotype but nearly straight ventrally in the Racine species. Siphuncle slightly ventrad of the center of the conch. The surface of the shell of the genotype is closely striated with numerous raised lines in a vertical direction. The surface of the Racine species is unknown.

Two species. *Gaspocyrtoceras cooperi* is from the Niagaran of the Gaspe peninsula; *Gaspocyrtoceras telleri* is from the Racine member of the Niagaran in Wisconsin.

### **32. Gaspocyrtoceras cooperi** new species

*Plate XXIV, fig. 10; plate XXV, figs. 1, 2*

The holotype is 25 mm. long. The radius of curvature of its convex ventral outline is about 20 mm. At the base of the specimen its cross section is circular with a diameter of 7.5 mm. At a point 20 mm. farther up its lateral diameter is estimated at 12.5 mm. Its dorsoventral one may be slightly less but that is uncertain. Eight annulations are preserved ventrally, two additional ones being exposed dorsally. The intervals between these annulations ventrally increase in length from 2 mm. at the base of the specimen to 3.5 mm. at its top. These annulations slope downward in a ventrad direction at a rate increasing toward the ventral outline, thus indicating the former presence of a relatively broad and shallow hyponomic sinus. The shell is almost a

third of a millimeter thick, and its surface is covered by numerous and very fine vertical raised lines, visible only under a lens, but distinct, 9 in a width of 1 mm. ventrally at the base of the specimen. The suture of the septum at its base curves only faintly downward laterally. The concavity of this septum equals 1.5 mm. The passage of the siphuncle through this septum is almost 0.75 mm. in diameter and its center is 2 mm. from the ventral wall of the conch.

Occurrence: Reddish Point, in the Port Daniel area on the Gaspé peninsula; from the West Point limestone. Holotype; U. S. National Museum, cat. no. 92798. Named in honor of Dr. G. Arthur Cooper.

Remarks.—This species differs from *Gaspocyrtoceras telleri* in its more rapid rate of enlargement, the presence of a distinct hyponomic sinus, and the known presence of numerous minute raised vertical lines on the surface of the shell.

### 33. *Gaspocyrtoceras telleri* new species

*Plate XXIV, figs. 7, 8, 9*

The holotype is 19 mm. long, 12 mm. of its ventral length belonging to the living chamber. The radius of curvature of its convex ventral outline is 30 mm. Its dorsoventral diameter increases from 10 mm. at its base to 11 mm. at its top, the corresponding lateral diameters being 10.5 mm. and 11.5 mm., indicating a slight depression of the cross section. Only 2 camerae are present. Of these, the lower one is 3 mm. long ventrally, and the upper one is 2.5 mm. long on that side. The sutures of the lower 2 septa curve slightly downward laterally, while that at the base of the living chamber curves more strongly downward in crossing the posterolateral side of an annulation and then follows the lower margin of this annulation. The conch apparently had attained its gerontic stage of growth. The septum at the base of the specimen has a concavity of 2 mm. The siphuncle is about half a millimeter in diameter at its passage through this septum. Its center is 3.5 mm. from the ventral wall of the conch. The annulations are straight and slope slightly downward in a

ventrad direction. The intervals between these annulations along the ventral outline, in ascending order, are 3.25 mm., 3.5 mm., 3.5 mm., and 4 mm. On the cast of the interior of the conch these annulations are only about 0.4 mm. in height above the intervening grooves, but on the cast of its exterior their elevation equals fully 0.7 mm. The crests of these annulations are almost half a millimeter wide, their elevation above the intermediate grooves being relatively abrupt. There is no trace of additional surface markings, but the latter, if present, must have been very fine, the enclosing rock being a dolomite not capable of preserving very fine markings. Cat. no. 92799. Plate XXIV, figs. 7, 8.

A second specimen, 15.5 mm. long, preserves only one of the lateral sides of the conch. It is of interest chiefly on account of a sinuous suture along the septum at the base of the living chamber which is identical in form with that of the holotype. Cat. no. 92799A. Plate XXIV, fig. 9.

Occurrence: Milwaukee, Wisconsin; from the Racine member of the Niagaran. From the collection of Edgar E. Teller, U. S. National Museum, cat. no. 92799.

#### CYRTOCYCLOCERAS new genus

Genotype: *Cyrtoceras urbanum* Barrande, *Système silurien du centre de la Bohême*, pt. 1, 699 (1867); pl. 198, figs. 11-20 (1866).

Conchs closely similar in form to *Gaspocyrtoceras*, but the surface of the shell is striated transversely instead of vertically. The annulations rise slightly in a ventrad direction in the species described by Barrande under the names *Cyrtoceras urbanum*, *Cyrtoceras semitectum*, and *Cyrtoceras nitidum*; but in *Cyrtoceras consanguine* they either slope downward or are almost directly transverse. The species described by Sowerby under *Lituities ibex* has a similar surface ornamentation. The species here mentioned are from the Middle Silurian of Czechoslovakia (former Bohemia) and Great Britain respectively.



**CALOCYRTOCERAS** new genus

Genotype: *Cyrtoceras cognatum* Barrande, Système silurien du centre de la Bohême, pt. 1, 633 (1867); pl. 199, figs. 35-45 (1866).

Conchs closely similar in form to *Gaspocyrtoceras*, but the surface of the shell is striated both transversely and vertically, the vertical striae being distinctly more distant from each other in the more typical species, described by Barrande under the names *Cyrtoceras cognatum* and *Cyrtoceras pergratum*. In *Cyrtoceras tesseratum* the vertical raised lines alternate in size and are more closely spaced. In *Cyrtoceras panderi* and *Cyrtoceras fenestratum* the vertical and transverse lines are subequal in size and in their relative distances apart, the intervals being minute in the second of these two species. In all of the species here named, excepting *Cyrtoceras panderi*, the annulations are straight but slope distinctly downward in a ventrad direction. In *Cyrtoceras panderi* they are directly transverse. All of the species mentioned are from the Middle Silurian of Czechoslovakia, formerly known as Bohemia.

**34. Calocyrtoceras bouleauxense** new species

Plate XVIII, fig. 3

Specimen 30 mm. long, rapidly enlarging and distinctly curved lengthwise. The radius of curvature of its convex ventral outline is 25 mm. Its dorsoventral diameter enlarges from 3 mm. at its lower end to 8 mm. at a point 20 mm. farther up. The crests of 5 annulations occur within a length of 8 mm. along the upper part of the specimen. These crests are relatively sharp and narrow, and are separated by much broader and relatively deep grooves. These crests are directly transverse to the curving vertical axis of the conch. There are distinct traces of transverse striae along the crests of several of the annulations, and apparently there also are traces of much finer and more crowded vertical striae, but the latter can not be identified with confidence.

Occurrence: Pointe-aux-Bouleaux, Gascons; in the Bouleaux

formation. Holotype; cat. no. 12727, Peabody Museum, Yale University.

**DARTOCERAS** new genus

Genotype: *Dartoceras nodosum* Foerste.

Cyrtconic conchs resembling *Hercoceras*, *Ptyssoceras*, *Trochoceras*, and *Ptenoceras* in the presence of nodes or wings along the ventrolateral parts of the conch, but the Port Daniel specimen is laterally compressed, instead of dorsoventrally depressed as in the genera named. Moreover, the surface of the shell is distinctly ribbed or annulated transversely, while the genera named are merely striated in that direction.

Named in honor of Jennie Doris Dart.

**35. *Dartoceras nodosum* new species**

*Plate XVIII, fig. 2*

Specimen 35 mm. long, curved lengthwise, the radius of curvature of its convex ventral outline changing from 25 mm. along its lower two-thirds to 30 mm. near its top. Its dorsoventral diameter enlarges from 8.5 mm. at its base to 17 mm. at its top, the corresponding lateral diameters being 6.5 mm. and 10 mm. The sutures of the septa are not shown at any point; hence nothing is known of its camerae, nor of its siphuncle. The surface of the shell is crossed by relatively narrow annulations, separated by grooves of about twice their width. These annulations number about 13 in a length equal to the dorsoventral diameter of the conch, when counted along the ventral outline of the upper part of the specimen. In addition there are transverse striae, about 7 or 8 in a length of 2 mm., best preserved within the upper 6 mm. of the length of the specimen, where the transverse annulations tend to become weak or obsolete, while the transverse striae remain. Along the lower part of the specimen the annulations slope strongly downward in a ventrad direction, while at its upper end this downward slope becomes relatively small compared with a plane directly transverse to the curving vertical axis of the conch. Owing to the obliquely lateral compression of the specimen it is difficult to determine its exact appearance before

crushing. However, the general course of the annulations appears to have been relatively straight laterally, with a moderate downward deflection ventrally. There is a slight downward deflection ventrolaterally and also dorsolaterally. Along the ventrolateral parts of the conch there is a tendency toward the recurrence of nodes at rhythmic intervals. In the specimen at hand these occur at 7 mm., 13 mm., and 22 mm. below the top of the specimen. Of these the two lower nodes are conspicuously elevated to a height of three-fourths of a millimeter, while the uppermost node consists of a moderate elevation of parts of two neighboring annulations for a width of 2 mm., these parts curving distinctly downward in a lunate manner.

Occurrence: West side of McInnis Cove, at the northern end of Port Daniel Bay; in the Bouleaux formation. Holotype, cat. no. 6811, National Museum of Canada.

#### **GASCONSOCERAS** new genus

Genotype: *Gasconsoceras pulchellum* Foerste.

Conch presenting the general aspect of a trochoceroïd, but the line of contact between the dorsal side of the living chamber and the preceding volution lies along the medium part of this chamber, instead of distinctly outside of this plane of symmetry. The conch enlarges so rapidly that it probably does not include more than two volutions. It is strongly ribbed transversely along its lateral and even its dorsal sides, but ventrally these ribs are much less conspicuous. They curve downward ventrally, indicating successive stages of a relatively deep hyponomic sinus. The surface of the genotype is finely striated parallel to the longitudinal central axis of the conch. There are also transverse striae, parallel to the transverse ribs.

#### **36. Gasconsoceras pulchellum** new species

*Plate XIII, fig. 2*

Specimen 63 mm. long, strongly curved lengthwise, compressed obliquely by pressure previous to fossilization, so that at present the dorsoventral diameter near the top of the specimen appears to be only 28 mm. where its lateral diameter is 34 mm. It is

possible that originally the dorsoventral diameter was greater. Evidence of contact with the preceding volution is seen along the median part of the dorsal side of the conch, the shell here being faintly concave for a width of 8 mm. Along this contact area the transverse ribs become obsolete, and along its median line there is a series of short transverse indentations which locate points of contact of the living chamber with crests of ribs belonging to the ventral side of the preceding volution. Apparently there was contact without actual attachment. The transverse ribs occur at a rate of 4 in a length of 27 mm. when counted along the median part of the ventral side of the conch. They are most prominent laterally and dorsally, but become much weaker toward the median part of their ventral course. The ribs are nearly directly transverse dorsally. From the dorsolateral parts of the conch as far as its ventrolateral side they are relatively straight, but from its ventrolateral parts they curve strongly downward ventrally for a width of 32 mm. and a depth of 10 mm., indicating the former locations of a deep and broad hyponomic sinus, broadly rounded at its base. In addition to the transverse ribs there are numerous but relatively inconspicuous striae and lines of growth parallel to the ribs; also sharply defined longitudinal lines, of which 6 to 8 occur in a width of 2 mm. These longitudinal lines are seen readily even without a lens, on cross-illumination.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype, cat. no. 13099, Peabody Museum, Yale University.

37. *Gasconsoceras planiventrum* new species

*Plate XXV, fig. 3; plate XIII, figs. 1A, B*

The holotype is 75 mm. long, and appears to have been depressed dorsoventrally. In its present condition the radius of curvature of its convex ventral outline is 55 mm. Its lateral diameter increases from 36 mm. near its base to 45 mm. at a point 70 mm. farther up, the corresponding dorsoventral diameters being 21 mm. and about 33 mm. The ventral side is almost flat, and the remainder of the cross section is almost semicircular. The transverse ribs rise about one millimeter above the inter-

vening grooves along the median part of the dorsal side of the conch at its midlength. Dorsolaterally their elevation equals fully 1.5 mm. Within a short distance of the ventrolateral angles these ribs disappear, but their place is taken by transverse raised lines, more numerous than the ribs, about 7 in a length of 5 mm. where most numerous along the median part of the ventral side. These raised lines are relatively weak, but at intervals of 3, 4, or 5 mm. single lines are more conspicuous. These lines indicate the former presence of a hyponomic sinus 12 or 13 mm. in depth, broadly rounded at its base. Under a lens there are traces of fine vertical raised lines and also of transverse ones, similar to those of the holotype of *Gasconsoceras pulchellum*. It differs from the latter chiefly in complete absence of ribbing along the median part of the ventral side of the conch. Plate XXV, fig. 3.

Occurrence: Near the mouth of Anse-à-la-Barbe River, Port Daniel; from the Gascons formation. Holotype; U. S. National Museum, cat. no. 92800.

Another specimen from the same locality and horizon is 150 mm. long ventrally and has a radius of curvature along its concave dorsal outline of about 50 mm. At midlength its dorsoventral diameter is 53 mm. and its lateral one is estimated to be about the same. Five transverse ribs occur in a length of 53 mm. when counted along its ventrolateral angles. These curve downward increasingly toward the ventral side of the conch but become obsolete a short distance beyond the ventrolateral angles, where their direction is continued by numerous transverse wrinkles which indicate the former presence of a broad and deep hyponomic sinus. Careful search reveals traces of longitudinal striae of which 5 or 6 occur in a width of 2 mm. Peabody Museum, Yale University, cat. no. 12750. Plate XIII, figs. 1A, B.

### 38. *Gasconsoceras obesum* new species

Plate XII, figs. 1A, B; plate XV, fig. 2; plate XXV, fig. 4

The holotype is 127 mm. long, measured along its ventral outline, the radius of curvature along this convex outline being 50 mm. Its dorsoventral diameter enlarges from 33 mm. near its

base to 48 mm. at its top, the corresponding lateral diameters being 30 mm. and 45 mm. The median part of the dorsal side of the conch is faintly concave, especially along the upper half of the specimen, suggesting a contact area, along which the transverse annulations or ribs become weak or nearly obsolete, but without any other evidence of contact. The transverse ribs are most prominent ventrolaterally, and thence become less distinct both in a dorsad direction and also ventrally. Seven ribs occur in a length of 48 mm. when counted along the median part of the ventral side of the upper end of the specimen. From the dorso-lateral parts of the conch their course is relatively straight as far as its ventrolateral sides, slanting downward at an angle of almost 20 degrees with a directly transverse plane. Thence they curve increasingly downward, indicating former locations of the hyponomic sinus which evidently was more narrowly rounded at its lower margin than in typical *Gasconsoceras pulchellum*. Transverse striae are distinctly defined along the upper part of the specimen, 4 occupying a length of 2 mm. These are much more regular and distinct than in the species just named. No longitudinal striae can be detected with certainty. Plate XII, fig. 1.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 12745, Peabody Museum, Yale University.

A second specimen, from the Gascons formation at Anse-à-la-Barbe, indicates an open form of coiling including at least one and a half volutions; possibly two volutions. Locally these volutions may have been in light contact. Only a single volution, the outer one, is preserved. The maximum diameter of this volution across the umbilical area is 80 mm. A clearly defined suture of a septum is located 65 mm. beneath the lowest part of the hyponomic sinus when measured along the ventral outline of the conch. This septum is assumed to locate the base of the living chamber. The dorsoventral diameter of this chamber at the aperture is 40 mm., the lateral diameter here being estimated at 46 mm. At the base of this chamber the corresponding diameters are 35 mm. and 33 mm. At 20 mm. beneath the base of the



living chamber they are 30 mm. and approximately 29 mm. One volution back from the aperture the dorsoventral diameter is estimated at 7 mm. At the point 20 mm. beneath the living chamber the conch appears to contract suddenly, probably due to dorsoventral crushing after the death of the animal. The space enclosed within this outer volution varies from 20 to 24 mm. in diameter. The number, curvature, and prominence of the annulations or ribs are as in the holotype. In addition there are transverse raised lines, similar in direction to the ribs, 6 to 8 in a length of 5 mm. along the upper part of its ventral side. Longitudinal lines also can be detected under a lens, about 7 in a width of 2 mm. at the top of the specimen. U. S. National Museum, cat. no. 92801. Plate XXV, fig. 4.

Vertical lines appear also in two other specimens in the U. S. National Museum, from the same horizon and locality. In one of these, 86 mm. long and with a dorsoventral diameter of nearly 35 mm. at its base, the passage of the siphuncle through the septum here appears to be approximately 2.5 mm. in diameter, its center being about 7 mm. from the ventral wall of the conch, judging from a little elevation at this point. The camerae formerly attached to this specimen are about 3.5 mm. in height when measured vertically to the septa near the ventral side of the conch. U. S. National Museum, cat. no. 9280 1A, B.

Another specimen is 127 mm. long when measured along its ventral outline. However, only 5.5 ribs occur in a length equal to the dorsoventral diameter of the conch. The more acute angulation of these ribs ventrad of the ventrolateral angles may be due to distortion after the death of the animal. At the base of the specimen the suture of the septum appears to have been directly transverse. The passage of the siphuncle through this septum is 3 mm. in diameter and its center is 9 mm. from the ventral wall of the conch, the dorsoventral diameter of the conch here being 37 mm. From Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation; Peabody Museum, Yale University, cat. no. 12729. Plate XV, fig. 2.

39. *Gasconsoceras cascapediense* new species*Plate XII, fig. 2*

Conch apparently very much compressed laterally, but the amount of this compression can not be determined even approximately. Judging from accompanying fragments of the same species, the lower part of the living chamber and at least the upper part of the phragmacone were in contact with the preceding volution along their dorsal outline. Only the last volution is exposed, and this enlarges dorsoventrally from 15 mm. to 37.5 mm. in a length of 220 mm., measured along the ventral outline of the conch. At the base of the living chamber its dorsoventral diameter is 33 mm. The length of this chamber was at least 80 mm. Along the upper part of the phragmacone about 3 camerae occur in a length equal to the dorsoventral diameter. The sutures of the septa curve downward at least 2 mm. laterally, reversing their curvature slightly in a sigmoid manner along the ventrolateral parts of the conch. The location of the siphuncle is unknown. The surface of the conch is crossed by transverse ribs, of which 5 occur in a length equal to the dorsoventral diameter of the conch along the upper part of the phragmacone. In their general course, on lateral view, these ribs resemble those of *Gasconsoceras obesum*, described on a preceding page, but they are more prominent along the median part of their ventral course. There are a few traces of coarse transverse striae, but longitudinal striae appear to be absent.

Occurrence: Black Capes, near Little Cascapedia River, 45 miles west of the Port Daniel area; in the middle part of the Gascons formation. Holotype; cat. no. 12723, Peabody Museum, Yale University.

**BICKMORITES** Foerste

Genotype: *Lituities bickmoreanus* Whitfield. Bull. Amer. Mus. Nat. Hist., 1, 191, pl. 21, figs. 1, 2, 3 (1885). See also Foerste, Denison Univ. Bull., Jour. Sci. Labs., 21, 48, pl. 19, figs. 1, 2, 3; pl. 20, fig. 1 (1925).

Gyroceracones of relatively large size, unwinding or becoming

relatively straight at gerontic stages of growth. Sutures of septa curving slightly downward laterally; apparently curving downward also ventrally. This siphuncle is located slightly ventrad of the center of the conch. Surface crossed by prominent rib-like annulations, which curve strongly downward ventrolaterally. There are also transverse raised lines, parallel to the annulations. Along the median part of the ventral side of the conch the annulations may become obsolete, and only the raised lines may remain. The latter indicate a relatively broad and deep hyponomic sinus. At gerontic stages of growth the annulations may disappear also at the top of the living chamber, only the transverse raised lines remaining. There are also traces of vertical or revolving raised lines.

The conchs from the Silurian of the Port Daniel area which are referred to this genus are closely related to the genotype, suggesting that the Gascons formation is approximately of the same age as the Liston creek limestone of Northern Indiana. *Bickmorites welleri* Foerste,<sup>4</sup> from the Racine of the Chicago area in northern Illinois, may be another closely related form.

Since *Bickmorites barbensis* differs from *Bickmorites americanus* chiefly in its more rapid rate of enlargement and in the slightly shorter interval between the crests of its transverse ribs, and since specimens of this type of structure are relatively common, there is a possibility that the slow rate of enlargement of *Bickmorites americanus* may be due to imperfect preservation of the conch.

#### 40. *Bickmorites americanus* (Billings)

Plate XVI, fig. 1

*Gyroceras (Lituiles) Americanum* Billings. Geol. Surv. Canada; Rept. of Progress for 1853-56, 309 (1857).

Conch 355 mm. long when measured along its convex ventral outline. A septum, 145 mm. from its upper end, is assumed to locate the base of the living chamber. That part which lies apicad of this specimen is 210 mm. long and forms slightly more than half a volution, with a diameter of 115 mm. across its umbilical area. The upper part of the living chamber is much

less strongly curved than the phragmacone. Since there is no trace of a dorsal contact zone the outer volutions of the conch evidently were gyroceran in their form of coiling. Most of the specimen consists of a cast of the exterior of the conch. Its dorsoventral diameter appears to increase from 22 mm. at the smaller end of the specimen to 35 mm. at the top of the phragmacone. Above the latter the rate of enlargement of the conch appears to have been small. The cross section of the conch appears to have been oval, with its dorsal part more narrowly rounded and its ventral part distinctly flattened. The surface of the conch is ribbed dorsally and laterally. Along the lower part of the living chamber 4 ribs occur within a length equal to the dorsoventral diameter of the conch. These ribs cross the dorsal side in an almost directly transverse manner; laterally they slope downward in a ventrad direction, at an angle of 10 to 15 degrees with a directly transverse plane, as far as the ventrolateral angles, beyond which they curve strongly downward and rapidly lose in prominence, disappearing soon along the lateral parts of the ventral side of the conch. Along the lower two-thirds of the living chamber the ribs are conspicuous, but along its upper third, for a length of 55 mm., they disappear and are replaced by more numerous, but much lower, transverse wrinkles or raised lines, parallel in their course to the ribs below. The hyponomic sinus, indicated by these transverse ribs and by the parallel raised lines, evidently was broad and deep. The uppermost camera is 7 mm. long. Those beneath may have been 8.5 mm. long, but the evidence is poor. The siphuncle is not exposed.

Occurrence: L'Anse-à-la-Barbe, 3 miles east of Port Daniel; From the Gascons formation. National Museum of Canada, cat. no. 6813.

Remarks—This probably is the specimen described by Billings, in the publication cited above, in the following words:

The length of the longest fragment measured along the out-side curve is twelve inches, its greatest diameter one inch and a half and the least one inch, thus tapering at the rate of about half-a-line to the inch; at least one-third of the outer whorl remains, and shews by its curvature that the diameter of the discoidal spire was four inches and a half nearly.

In the preceding general description of this species Billings stated:

The dorso-ventral and lateral diameters appear to be about equal in the fragments examined, which are however somewhat distorted; the siphuncle is small and slightly eccentric, being nearest the dorsal aspect (at present called ventral), the septa are convex (here called concave) and distant 4 lines (or 8.5 mm.).

The general aspect of the specimen here figured is similar to that of *Bickmorites bickmoreanus* (Whitfield), as figured in the Denison University Bulletin, Jour. of the Sci. Labs., 21, pl. 19, in 1925. In that specimen the siphuncle also was located slightly ventrad of the center of the conch.

The specimen here figured is selected as the lectotype. It is the only one received for study from the National Museum of Canada. Apparently it is a more slender form than the holotype of *Bickmorites barbensis*, described in the following lines. It should be remembered, however, that most of this specimen consists merely of a cast of the exterior of the conch and that this cast is imperfect. The writer, therefore, may have been in error in his estimate of the original dorsoventral diameter of the conch, though this error apparently was made also by Billings in his original description, where he gives the greatest dorsoventral diameter as one inch and a half in *Bickmorites americanus*, instead of 2 inches as in the holotype of *Bickmorites barbensis*, described next.

#### 41. *Bickmorites barbensis* new species

Plate XXVI, fig. 1; plate XIV, figs. 1, 2; plate XV, figs. 1A, B

The holotype has a maximum diameter of 200 mm. when measured from the aperture across its umbilical area. The part preserved is 580 mm. long when measured along its ventral outline. The uppermost septum definitely exposed is 230 mm. beneath the aperture, so that the living chamber may be 230 mm. long. Beneath this point the phragmacone is preserved for a length slightly exceeding one volution. The maximum diameter of this phragmacone, across its umbilical area, is 130 mm., the diameter at right angles to the latter being 102 mm. At its

smaller end the radius of convex curvature of its ventral outline is 30 mm., enlarging in a half volution to 50 mm., and in another half volution to 80 mm., changing to about 200 mm. along the upper half of the living chamber. At the lower end of the specimen the ventral side of the conch is so near the dorsal side of the following volution that earlier parts of the conch may have been in light contact locally, but there is no evidence of such a contact along the dorsal side of that part of the phragmacone preserved. The dorsoventral diameter of the conch enlarges from approximately 16 mm. at its lower end to 30 mm. half a volution farther up, and to 43 mm. at the uppermost septum exposed, reaching a diameter of 48 mm. at a point about 35 mm. beneath the aperture ventrally. It is this conspicuously larger dorsoventral diameter which distinguishes this specimen from that regarded as the holotype of *Bickmorites americanus*. The cross section of the conch is approximately oval with the ventral side conspicuously flattened. The lateral sides are broadly rounded, their general surfaces converging in a dorsad direction. The dorsal side of the cross section is more narrowly rounded. The surface of the conch is plicated conspicuously, except along the upper 30 mm. of the length of the living chamber where the plications are replaced by slightly elevated but broad raised lines, parallel to the plications, and numbering about 5 in a length of 15 mm. Along the lower half of the phragmacone, at dorsoventral diameters of 20 mm. and 30 mm., there are 4 crests of plications in a length corresponding to these diameters, their number increasing to 5 at the top of the phragmacone and the entire length of the living chamber where these diameters are 40 and 50 mm. The plications are conspicuous dorsally and laterally, being most conspicuous ventrolaterally, but on the flattened surface of the ventral side they soon disappear and are replaced by more numerous transverse lines which follow the same direction as the plications. The transverse lines, along with the plications, indicate the former presence of a deep and broad hyponomic sinus which was between 20 and 25 mm. in depth along the upper part of the phragmacone and the living chamber. The plications slope increasingly downward in a ventrad direction, curving more abruptly downward ventro-



laterally, the lower margin of former locations of the hyponomic sinus being evenly and rather broadly rounded. The sutures of the septa curve downward slightly laterally and still less ventrally, leaving low ventrolateral saddles. Holotype, Redpath Museum, cat. no. 2-3502. Plate XXVI, fig. 1.

A closely similar specimen, from the same locality and horizon, has a maximum diameter of 185 mm. from the aperture across its umbilical area. The uppermost septum exposed is at a dorsoventral diameter of 35 mm., the phragmacone being outlined for slightly more than one volution. The number of plications in a length equal to the dorsoventral diameter increases from 4 at the lower end of the living chamber to 5 at its top. At the aperture this dorsoventral diameter is 51 mm., and here, for a length of 40 mm., the plications are replaced by low transverse lines parallel to the plications. Here there are traces also of longitudinal fine striae, about 12 in a width of 5 mm. The upper plications are more directly transverse laterally than those along the lower part of the living chamber and along the phragmacone. At the base of this chamber and the upper part of the phragmacone the last volution is in contact with the preceding one along the crest of the plications. The ventral side of the living chamber is flattened medially along its lower half but is more evenly rounded farther up. U. S. National Museum, cat. no. 92802.

A living chamber, 240 mm. long ventrally, attains a maximum dorsoventral diameter of 49 mm., its lateral one being estimated at 42 mm. The ventral side of the cross section is rounded with a radius of 30 mm. Paratype; National Museum of Canada, cat. no. 6814. Plate XIV, fig. 2.

Another specimen, 105 mm. long ventrally, enlarges dorsoventrally from 35 mm. at its base to 42.5 mm. at its top. At a dorsoventral diameter of 35 mm. there are 2 camerae in a length of 18.5 mm. There are numerous longitudinal striae, about 8 in a width of 2 mm., similar to those of *Gasconsoceras pulchellum*, but the general rate of enlargement is in agreement with that of *Bickmorites barbensis* at the same stage of growth. Paratype; National Museum of Canada, cat. no. 6812. Plate XIV, fig. 1.

A fragment of a living chamber, 115 mm. long ventrally, en-

larges in this length dorsoventrally from 42 mm. at its base to 46 mm. at its top, its lateral diameter being estimated at 38 mm. The specimen is of interest chiefly on account of the distinctness of the transverse striae. Dorsally they occur at the rate of 6 in a length of 5 mm. Ventrally they tend to be more crowded. Paratype; National Museum of Canada, cat. no. 6815. Plate XV, figs. 1A, B.

A specimen, 250 mm. long on its ventral outline, includes most of the living chamber and a small part of the last volution of the phragmacone. Its maximum dorsoventral diameter equals 57 mm., at least in the present compressed condition of the specimen. The gerontic stage of the conch, at which the transverse plications disappear, is missing. Ventrolaterally it exposes poorly preserved transverse raised lines, about 6 in a length of 7 mm., parallel to the plications. On the ventral surface there are numerous low longitudinal lines, about 5 in a width of 1 mm. locally. U. S. National Museum, cat. no. 92802A.

Another specimen, 150 mm. long ventrally, consists of the upper part of the phragmacone and the lower part of the living chamber, the latter being preserved for a length of 50 mm. At the base of the living chamber its dorsoventral diameter is 40 mm. Here 4 camerae occur in a length of 41 mm. At a dorsoventral diameter of 39.5 mm. the center of the siphuncle is about 15 mm. from the ventral wall of the conch, its passage through the septum being nearly 4 mm. in diameter. The sutures of the septa curve downward about 3 mm. laterally and 2 mm. ventrally, leaving relatively low ventrolateral saddles. The concavity of the uppermost septum equals 12 mm. Locally there are vertical striae, about 8 in a width of 3 mm. U. S. National Museum, cat. no. 92802B.

Occurrence: All of these specimens are from near the mouth of the Anse-à-la-Barbe River, 3 miles east of Port Daniel; from the Gascons formation.

Remarks.—It is evident that the common species at this locality is the one here described as *Bickmorites barbensis*. Unfortunately, the only specimen specifically mentioned by Billings in his description of the specimen here described under *Bickmorites*

*americanus*, appears to be an apparently more slender form, here selected as the lectotype of his species. The broader form is so closely similar to the more slender one that the discrimination of the broader one under a distinct name is regarded as only tentative.

42. *Ormoceras* sp. (West Point)

Plate XVII, figs. 3A, B

Specimen originally at least 175 mm. long, including only the phragmacone; at present broken into fragments that do not fit together, the most continuous part being 115 mm. in length. Only its ventral side is preserved, and this exposes the siphuncle. The original diameter of the conch is estimated to have been 20 mm. at its base, and its angle of enlargement is estimated at 7 degrees. The number of camerae in a length equal to the diameter of the conch is estimated at 6.5 at points between 50 and 60 mm. above its base. The concavity of the septa equals 6 mm. Where the diameter of the conch is 25 mm. the center of its siphuncle was at least 2 mm. ventrad of the center of the conch. The segments of the siphuncle are moderately nummuloidal in form, their diameter being nearly 8 mm. where the length of the camerae is 5 mm. The vertical outlines of these segments are semicircular. The passage of the siphuncle through the septa is 4 mm. in diameter. The septal necks are scarcely half a millimeter in length.

Occurrence: Along the shore, between West Point and Indian Point, Port Daniel; in the West Point formation. Cat. No. 12753, Peabody Museum, Yale University.

Remarks.—This specimen is of interest chiefly because it indicates the presence of the genus *Ormoceras* in the faunas here studied.

43. *Armenoceras wellsae* new species

Plate XVIII, figs. 1A, B

Specimen 135 mm. long, preserving only its ventral half; enlarging laterally from a diameter of 70 mm. at its lower end to 82 mm. at a point 95 mm. farther up. The ventral side of the conch

apparently was moderately flattened. The number of camerae in a length equal to the lateral diameter of the conch equals 7. The sutures of the septa curve downward ventrally about 10 mm. below their level laterally. The distance of the siphuncle from the ventral wall of the conch increases from 3 mm. at its lower end to 9 mm. at a point 120 mm. farther up. The dorsoventral diameter of the siphuncle varies between 26 and 25 mm. along its lower 9 segments and then diminishes gradually along the upper 3 segments to 20 mm. Its lateral diameter appears to be about 33 mm. along the entire length of the specimen. Its segments are nummuloidal. The septa curve downward toward the siphuncle both ventrally and dorsally, but their ventral slope is greater. The segments of the siphuncle slant downward in a dorsad direction at a moderate angle. The vertical outlines of these segments are similar both on the ventral and dorsal sides of their connecting rings, but on their ventral side the septal necks curve downward more strongly in a dorsad direction, while on their dorsal side these necks are more nearly horizontal. On their ventral side these necks appear to be reduced to an undivided lamella, but dorsally their length is at least two-fifths of a millimeter. The surface of the shell is ornamented with numerous vertical raised lines or striae, about 13 in a width of 10 mm. at the top of the specimen.

Occurrence: One and a half miles east of Gascons, in the railroad cut; from the La Vieille limestone. Holotype; cat. no. 12710, Peabody Museum, Yale University. Named in honor of Josephine Wells.

#### 44. *Armenoceras gasconsense* new species

*Plate XXII, figs. 2A, B*

Specimen 55 mm. long, estimated to have had a lateral diameter of 80 mm.; rate of enlargement unknown. Ventral side either evenly rounded or only slightly flattened. Four camerae occur in a length of 53 mm., indicating that originally 6 camerae occupied a length equal to the lateral diameter of the conch. The sutures of the septa curve downward ventrally about 7 mm. below

their level laterally. The septa curve strongly downward toward the siphuncle ventrally, and apparently also dorsally. The siphuncle is 5 mm. from the ventral wall of the conch. Its segments are nummuloidal, and slant downward in a dorsad direction at an angle of 15 degrees with the horizontal. In a direction parallel to this slant, the dorsoventral diameter of these segments varies between 36 and 37 mm. The constriction at the septal necks is 18 or 19 mm. in diameter. On the ventral side of the siphuncle the septum appears to be in contact with the upper part of the underlying connecting ring for a width of 3 mm., and with the base of the overlying connecting ring for an additional width of 8 mm., making a total of 11 mm. There is a slight upward curvature of the septum where it becomes free from the underlying connecting ring. Along its entire length of contact with the overlying ring the septum slants strongly downward in a dorsad direction. On the dorsal side of the siphuncle the adjacent connecting rings are separated from each other by the septal necks which are almost 1 mm. long. On this side of the siphuncle the entrant angles made by the septal necks are almost horizontal.

Occurrence: One and a half miles east of Gascons; in the La Vieille limestone. Holotype; cat. no. 6816, National Museum of Canada. A closely similar specimen was found at the same horizon at Barrachois, Port Daniel; it is numbered 12708, in the Peabody Museum, at Yale University.

A third specimen was found at the same horizon in the railroad cut 6 miles east of Port Daniel. It is 65 mm. long and is estimated to have been about 60 mm. in diameter. Six camerae occur in a length of 61 mm. and the sutures of the septa curve distinctly downward ventrally. The concavity of the septa equals 13 or 14 mm. The siphuncle is 31 mm. in diameter and is about 7 mm. distant from the ventral wall of the conch. On the ventral side of the siphuncle the septa are adnate to the lower face of the segments of the siphuncle for a diagonal width of 7 or 8 mm. measured from the septal necks. On the dorsal side this adnation is limited to a width of 5 mm. Compared with the holotype these segments are slightly shorter. U. S. National Museum, cat. no. 92803.

45. *Huronina gaspensis* new species*Plate IX, fig. 2*

The holotype is 130 mm. long. Neither the diameter of the conch nor that of the siphuncle can be determined with accuracy though the upper expanded part of each segment of the siphuncle evidently is very close to the ventral wall of the conch and possibly is in contact with the latter. The siphuncle is exposed along a section cut vertically but at an angle of 45 degrees with the dorsoventral plane of symmetry of the conch. Along this section there are 7 segments of the siphuncle in a length of 100 mm. The upper, more expanded portion of each segment slopes distinctly but only slightly downward in a dorsad direction. The lower half of each segment presents concave vertical outlines along which the underlying septa are adnate, becoming free farther up where the concave vertical curvature reverses to convex along the upper half of each segment. Compared with typical *Huronina obliqua* Stokes the upper, more annular part of each segment is more broadly rounded in vertical section and forms a relatively greater part of the height of each segment, but the relationship to that species evidently is close.

Occurrence: Behind LeGrande Hotel at Port Daniel, Gaspé peninsula; from the La Vieille formation. Holotype; U. S. National Museum, cat. no. 92804. Plate IX, fig. 2.

Remarks.—Another specimen of *Huronina*, possibly belonging to the same species, but apparently distorted, was found at the same horizon in the railroad cut about 6 miles east of Port Daniel. U. S. National Museum, cat. no. 92805.

## PERIOIDANOCERAS Foerste

Genotype: *Periodanoceras rotundatum* Foerste. Denison Univ. Bull., Jour. Sci. Labs., 25, 92, pl. 17, figs. 1A, B (1930).

Conchs circular in cross section, rapidly enlarging and strongly curved lengthwise. Dorsal outline gibbous along upper part of phragmacone. Sutures of septa curving downward only faintly laterally, but rising at a moderate angle ventrally. The siphuncle is almost in contact with the ventral wall of the conch, and its



segments are similar to those of *Amphicyrtoceras*, contracting abruptly at the septal necks in the new species described here.

46. *Periodanoceras* (?) *chaleurense* new species

*Plate XI, fig. 3*

Specimen 80 mm. long, measured along its convex ventral outline. The radius of curvature of this ventral outline is about 120 mm. At the base of the specimen its dorsoventral diameter is about 64 mm. At its top the dorsoventral diameter appears to be only slightly greater, probably not equalling 70 mm., though the exact rate of enlargement is not known. The cross-section of the conch appears to have been approximately circular, but no exact measurements are possible. The number of camerae within a length equal to the dorsoventral diameter is estimated at about 12 or 13, if counted along their ventral outline. The concavity of the septa is about 20 mm. The sutures of the septa apparently are almost directly transverse. The siphuncle is about 2 mm. from the ventral wall of the conch. Its diameter directly transverse to its length is 10 mm. where the dorsoventral diameter of the conch varies between 64 and 67 mm. Its segments are nummuloidal. In a direction parallel to the septa, where the direct distance between the septa is 4 mm., the diameter of its segments dorsoventrally varies between 11 and 14 mm., contracting to 5 or 6 mm. at the septal necks. The septal necks appear to be less than half a millimeter in length. Their lower part or brim is curved abruptly outward and rises so as to be nearest to the immediately overlying septum at a point 2 mm. from the septal foramen. On the dorsal side of the siphuncle, the upper part of each connecting ring is close to the overlying septum for a considerable width, while its lower part forms a considerable angle with the septum beneath. On the ventral side of the siphuncle, the lower side of each connecting ring is adnate to the underlying septum for a width of about 6 mm., while its upper part approaches the overlying septum for a width of only 3 mm. The surface of the cast of the interior of the conch is smooth. No part of the surface of the shell is preserved.

Occurrence: From the shore at Indian Point, Port Daniel; in

the Indian Point formation. Holotype; cat. no. 12774, Peabody Museum, Yale University.

Remarks.—This specimen is not known sufficiently well for exact generic determination. Its reference to *Perioideanoceras* is merely tentative. With the latter genus it has in common its approximately circular cross-section, moderate lengthwise curvature, and the nearly directly transverse course of the sutures of its septa. However, its dorsal outline is not known to be gibbous toward the upper end of the phragmacone, and other differences of a more important character probably will be revealed in case the structure of the siphuncle of typical *Perioideanoceras* ever becomes known.

47. *Amphicyrtoceras cooperi* new species

Plate XVI, figs. 2A, B

Specimen 82 mm. long, consisting of a living chamber 47 mm. long, to which 8 camerae still are attached. Both its ventral and dorsal outlines are evenly convex along the lower three-fourths of their length, but the convexity of its ventral outline is greater. Toward its upper end the living chamber contracts both dorsoventrally and laterally, resulting in a more or less distinctly convex outline in these directions along midheight of the living chamber, becoming concave near the aperture. For instance, the radius of curvature of the convex ventral outline of the specimen is 50 mm. along most of its length, but at 20 mm. beneath the supposed margin of the aperture this distinctly convex curvature reverses to slightly concave. In a similar manner the radius of curvature of most of the dorsal outline is 80 mm., until a point 40 mm. above its base is reached, above which this curvature reverses from convex to concave. The lateral vertical outlines have a radius of convexity of 60 mm., reversing to concave at 50 mm. above the base of the specimen. The maximum lateral diameter of the conch is 50.5 mm., the corresponding dorsoventral diameter being 41.5 mm. It is estimated that the number of camerae originally occupying a length equal to the dorsoventral diameter is ten and a half. On lateral view the sutures of the septa slant moderately downward

from the dorsal side of the conch toward its ventrolateral part, but along the middle of its ventral side, for a width of 25 mm., they rise slightly. The concavity of the septum at the base of the specimen is a little over 2 mm. That segment of the siphuncle which is exposed at its base has a diameter of almost 11 mm., but it can not be determined to what diameter it contracts at the septal foramen. Its form is nummuloidal, apparently with strongly rounded lateral vertical outlines. Its center is 11 or 12 mm. from the ventral wall of the conch, where the dorsoventral diameter of the latter is 28 mm. The surface of the shell is marked by numerous vertical and transverse striae, the former being somewhat more narrowly and sharply elevated. At the base of the ventral side of the living chamber there are 4.5 to 5 vertical primary striae in a width of 5 mm., alternating with an equal number of secondary ones, the latter being much less conspicuous. The transverse striae here number from 5.5 to 6.5 in a length of 5 mm. In a general way these transverse striae are directly transverse to the curving vertical central axis of the conch.

Occurrence: Above La Vieille, in the railroad cut, Gascons; in the La Vieille formation. Holotype, cat. no. 13148, Peabody Museum, Yale University. Named in honor of G. Arthur Cooper.

Remarks.—This species is characterized by the neck-like extension of the upper part of its living chamber, and by the conspicuous vertical and transverse striae ornamenting the surface of its shell.

#### GOMPHOCERAS Sowerby

Genotype: *Orthoceras pyriforme* Sowerby, in Murchison's Silurian System, 620, pl. 8, fig. 19, upper figure under this number only (1839). See also Blake, British Fossil Cephalopoda, 192, pl. 22, figs. 2, 2a (1882); and Foerste, Denison Univ. Bull., Jour. Sci. Labs., 21, 353, pl. 49, figs. 1A, B; 2A, B (1926).

In a former publication, cited above, Foerste attempted to follow Blake in interpreting the aperture of typical *Gomphoceras* as consisting of a large elliptical dorsal opening, elongated in a

dorsoventral direction, from which a narrow hyponomic sinus extended in a ventrad direction. However, direct examination of the genotype in the British Museum showed that the dorsal aperture was not preserved. In a similar manner the specimen figured by Blake under the name *Gomphoceras pyriforme* also does not preserve the outline of the aperture dorsally. In other words, it is not known that the dorsal part of the aperture of typical *Gomphoceras pyriforme* was elliptical in form, and without lateral lobes. A specimen from the Lower Ludlow, in Shropshire, England, belonging to the Geological Museum in Copenhagen leads to a similar conclusion.

There is a possibility, however, that eventually the genotype of *Gomphoceras* may turn out to be some form of *Hexameroceras* or *Tetrameroceras*, or even *Mandaloceras*. Under these conditions it is highly desirable that a search be made for additional specimens of the species serving as the genotype.

#### 48. *Mandaloceras subgracile* (Billings)

*Plate XXII, figs. 1A-1F; plate XXIV, figs. 3, 4, 5; plate XXVI, fig. 2*

*Gomphoceras subgracile* Billings. Geol. Surv. Canada, Rept. Progress for 1853-56, 311 (1857).

*Mandaloceras subgracile* Foerste. Denison Univ. Bull., Jour. Sci. Labs., 24, 372, pl. 45, figs. 3A, B; pl. 46, figs. 3A, B (1929).

The holotype is 70 mm. long and consists of a living chamber with 13 camerae still attached. The specimen is so poorly preserved and so much distorted that its orientation is in doubt. An attempt at restoration of the aperture suggests that it is a species of *Mandaloceras*, the aperture having 2 dorsolateral lobes and a long hyponomic sinus. In the figures here published on plate XXII, fig. 1D is an attempt at a restoration of the aperture as shown by fig. 1C. Fig. 1E is a restoration of a lateral view as shown by fig. 1B, the hyponomic sinus being on its left side. Fig. 1F is a restoration of its ventral side, as shown by fig. 1A. On plate 46 accompanying the description by Foerste published in 1929, and cited above, an attempt at a restoration of its dorsal side is attempted by fig. 3B. Of the aperture only the left

dorsolateral lobe is well preserved. The dorsal crest which curves forward in the notch between the two dorsolateral lobes also is fairly well indicated. The remainder is chiefly restoration, and leaves much to be desired.

Occurrence: Anse-à-la-Barbe, Port Daniel; either from the Gascons or the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 3053. Plate XXII, figs. 1A-F.

As a matter of fact, this holotype described by Billings is practically unidentifiable. Fortunately four specimens were found by Dr. G. Arthur Cooper near the mouth of the Anse-à-la-Barbe River, in the Gascons formation, which are of about the same size and which are assumed to belong to the same species.

One of these was broken across and exposes the siphuncle distinctly. This siphuncle is assumed to locate the ventral side of the conch. The specimen is 78 mm. long, 34 mm. of this length belonging to the living chamber. Its lateral diameter enlarges from 26 mm. at its base to 37 mm. at a point 25 mm. farther up, near the middle of the second camera beneath the living chamber. From here it diminishes to 26.5 mm. at a point 29 mm. farther up, contracting thence rapidly to 17 mm. at the aperture. The ventral outline has a radius of convex curvature of 60 mm., one of the lateral outlines having a radius of 70 mm. and the other a radius of 80 mm. Six camerae occur in a length of 29 mm., the lowest one being 4.5 mm. long and the uppermost one 5.5 mm. long. The sutures of the septa are straight and appear to converge slightly toward the dorsal side of the conch. At a lateral diameter of 36.5 mm. the concavity of the septum equals 9 mm. and the siphuncle has a diameter of 6 mm., its center being 8 mm. from the ventral wall of the conch. At the base of the specimen the siphuncle is 3 mm. in diameter and its center is 5.5 mm. from the ventral wall of the conch. The aperture, as far as preserved, appears to have been subtriangular in form and rounded at all three angles, but more narrowly rounded ventrally than dorso-laterally. In that respect it differs from typical *Mandaloceras* in which the aperture is more nearly T-shaped. Cat. no. 92806. Plate XXVI, fig. 2.

The second specimen is 73 mm. long, 36 mm. of this length

belonging to the living chamber. Its lateral diameter enlarges from 19 mm. at its base to 35 mm. at a point 29 mm. farther up and then diminishes to 32.5 mm. at the base of the living chamber and to 28.5 mm. at a point 12 mm. farther up, above which it contracts more rapidly. Regarding the siphuncular side of the conch as ventral, the radius of convex curvature of this outline is 60 mm. along almost its entire length. The dorsal outline, however, is distinctly convex only from about 6 mm. above its base to a point 30 mm. farther up. Above and below these points the dorsal outline is slightly concave, at least in the present condition of the specimen. Ventrally there are 9 camerae in a length of 40 mm., their length increasing from about 3 mm. at the base of the specimen to 6.5 mm. at the eighth camera, and then diminishing to 3.5 mm. at the ninth. The sutures of the septa are straight and slope downward in a ventrad direction, at least in the present condition of the specimen. The camerae shorten slightly in a dorsad direction. The septum at its base has a concavity of 3 mm. The siphuncle here is 2.5 mm. in diameter and its distance from the ventral wall of the conch is approximately 1.5 mm. as near as can be determined. Near the midheight of one of the lateral sides there are faint traces of transverse banding, about 3 bands in a length of 4.5 or 5 mm. Cat. no. 92806 A. Plate XXIV, fig. 5.

A third specimen from the same locality appears to be depressed dorsoventrally owing to compression after the death of the animal. In its present condition its lateral diameter enlarges from 28 mm. at its base to 39 mm. at a point 20 mm. farther up and then diminishes to 36 mm. at the base of the living chamber which is 14 mm. farther, and to 33 mm. after an additional interval of 10 mm., above which it contracts more rapidly toward the aperture. The maximum dorsoventral diameter, at 20 mm. above the base of the specimen, equals 32 mm. On the better preserved side 7 camerae occur in a length of 34 mm. These enlarge in height from 4 mm. at the lowest camera to 5 mm. at the sixth, diminishing thence to 3 mm. at the seventh. The specimen can not be oriented with confidence, there being no trace of the siphuncle, and the aperture being only vaguely indicated. Cat. no. 92806 B. Plate XXIV, fig. 3.



The fourth specimen of this series is 61 mm. long, 26.5 mm. of this length belonging to the living chamber. Its orientation is uncertain but it appears to be compressed laterally. In that case its maximum or dorsoventral diameter enlarges from 22.5 mm. at its base to 40.5 mm. at a point 26 mm. farther up, diminishing to 36.5 mm. at the base of the living chamber which is 6 mm. farther, and to 30 mm. after an additional distance of 12 mm., beyond which it contracts more rapidly toward the aperture. The maximum lateral diameter is 31 mm. The ventral side appears to be that toward which the sutures of the septa slope downward. If that is the case there is a trace of the two dorso-lateral lobes of the aperture but not of the hyponomic sinus. Eight camerae occur in a length of 34 mm., the lowest having a length of 3 mm., and the seventh a length of 5.5 mm., the eighth varying from 3 to 4 mm. in length. The sutures of the septa are straight and slope downward in a direction supposed to be ventral. There are traces of transverse raised lines, 6 or 7 in a length of 5 mm. Cat. no. 92806 C. Plate XXIV, fig. 4.

All of these 4 specimens are in the U. S. National Museum. They all have their maximum diameter at the second or third camera beneath the living chamber. They contract distinctly toward the top of the phragmacone, and then at a less rate along the lower half of the living chamber. This sets the lower half of the living chamber off from the adjacent part of the phragmacone, and apparently is a diagnostic feature of the species.

The species appears to be relatively common but additional specimens will be needed to secure an adequate knowledge of its structure. The information as to the exact form of its aperture is especially indefinite.

#### 49. *Mandaloceras erectum* new species

Plate XX, figs. 1A, B

Specimen consisting chiefly of a living chamber 40 mm. long, measured from the suture of the septum at its base. Beneath this suture, the septum curves downward an additional distance of 8 mm. The suture rises in a ventrad direction at an angle of 5 degrees above the horizontal. The dorsal outline of the chamber is relatively straight for a length of 25 mm. above this suture and

then curves concavely inward as far as the margin of the aperture. The ventral outline has a radius of convexity of about 45 mm. for a length of 23 mm. and then curves concavely inward as far as the lower margin of the hyponomic sinus. The lateral walls curve with a radius of convexity of 60 mm., converging at the same time. The dorsoventral diameter of the chamber is 33 mm. at its base and 23.5 mm. at its most constricted part, 1.5 mm. below the lower margin of the hyponomic sinus. The latter projects forward about 1 mm. beyond this constricted part. The lateral diameter of the chamber is 29 mm. at its base, and contracts to 17.5 mm. at the lateral margins of the two dorsal lobes of the aperture. What is left of the aperture is subtriangular in outline, but originally it probably had an outline comparable with *Mandaloceras scrinium* (Hall). The passage of the siphuncle through the septum at its base is 4 mm. in diameter, and its center is 5 mm. from the ventral wall of the conch. Parts of two short camerae, apparently belonging to this specimen, accompany the latter. Each of these apparently is about 3 mm. long. In these the septal foramen is 2.75 mm. in diameter and the segments of the siphuncle appear to be in contact with the septa beneath for a diameter of 5.2 mm. It is assumed that the living chamber was compressed laterally after the death of the animal and that its original cross-section was more nearly circular.

Occurrence.—Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 12743, Peabody Museum, Yale University.

Remarks: Although the form of the aperture of this specimen appears to have been similar to that of *Mandaloceras scrinium* (Hall), the general appearance of its conch may have been more nearly like that presented by the species described by Barrande under the name *Gomphoceras simplex* (Système Silurien du centre de la Bohême, pl. 68, 1865), its dorsal outline apparently being nearly straight and its ventral outline only gently convex.

#### 50. *Hexameroceras inflatum* Foerste

Plate XXI, figs. 1A-E

*Gomphoceras inflatum* Billings, a manuscript name of an undescribed specimen selected by Hyatt as a genotype of his genus

*Septameroceras*, but no description of this species ever was published either by Billings or Hyatt. See also Bassler's Bibliographic Index of American Ordovician and Silurian Fossils, 1157, under *Septameroceras*, (1915).

*Hexameroceras inflatum* Foerste, Jour. Sci. Lab. Denison Univ., 24, 381, (1929).

Specimen 75 mm. long, erect, enlarging to a dorsoventral diameter of 50 mm. and a lateral one which originally probably was equally great, both diameters attained at 35 mm. below the top of the specimen. The conch apparently enlarged at an approximately even rate along the greater part of the phragmacone, and contracted fairly evenly toward the dorsal part of the aperture. The base of the living chamber is assumed to be located at about the same level as the maximum diameters. Three pairs of lateral lobes are poorly outlined, chiefly along the right margin of the aperture. The total length of the aperture in a dorsoventral direction is about 42 mm. The width of the dorsal part of the aperture at its posterior pair of lateral lobes is estimated at about 23 mm. The broadly reentrant angle between these lobes had a depth of at least 3 mm. At the middle pair of lateral lobes the width of the aperture is estimated at 20 mm. At the anterior pair of lobes it is estimated at 9 mm. The linearly contracted part of the aperture enlarges in a ventrad direction and finally forms the spout-like projection at the hyponomic sinus. A small and low protuberance is located along the dorsoventral plane of symmetry of the conch at a distance of 5 mm. back from the crest of that part of the dorsal margin of the aperture which curves forward between the two dorso-lateral lobes of the aperture. This protuberance has been interpreted by Hyatt as the end of a seventh or azygous lobe of the dorsal part of the aperture. However, that part of the specimen posterior to the incurved dorsal crest of the margin of the aperture, between its two dorso-lateral lobes, is covered by a black film, which appears to have been one of the layers of the original shell of the conch. With this interpretation in mind, it is impossible to accept the protuberance as an evidence of a seventh lobe.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons

formation. Holotype; cat. no. 6817, National Museum of Canada.

Remarks.—Considering the existence of such genera as *Trimeroceras* and *Pentameroceras*, there is no reason why such a genus as *Septameroceras* should not exist. However, neither *Gomphoceras inflatum* Billings (manuscript name) nor *Gomphoceras septore* Hall have turned out to possess such a structure. Moreover, I have been unable to find any trace of the specimen from Elora, in Ontario, referred by Whiteaves to Hall's species *Gomphoceras septore*, in his contributions to Palaeozoic Fossils (of Canada), vol. 3, pp. 39 and 102, published in the years 1884 and 1895. Apparently this Elora specimen has been lost.

51. *Hexameroceras erectum* new species

Plate XXIV, figs. 1, 2

The holotype is 56 mm. long, 46 mm. of this length belonging to the living chamber. The specimen is distorted obliquely to its dorsoventral plane of symmetry. In its present condition its dorsoventral diameter enlarges from 44 mm. at the base of the living chamber to 47 mm. at a point 10 mm. farther up, and then decreases to 42 mm. at the base of the spout-like projection formed by the hyponomic sinus, at a point 15 mm. higher. The corresponding lateral diameters, in the present condition of the specimen, are 36 mm., 38 mm., and 33 mm., decreasing to 16.5 mm. at the middle pair of lateral dorsal lobes of the aperture, 41.5 mm. above the base of this living chamber. The anterior pair of lateral lobes has a total spread of scarcely 10 mm. and is weakly indicated. The middle pair has a spread of 16.5 mm. and is distinctly outlined. The posterior pair is indicated only on the left side of the chamber, its lateral spread being estimated at 23 mm. There is a faint median elevation along the median line of the chamber, posterior to the posterior pair of lobes, as in *Hexameroceras inflatum*, but this elevation is covered with a black film, suggesting that no seventh dorsal lobe was present here.

Compared with *Hexameroceras inflatum* (Foerste) this living chamber contracts less toward the aperture, the spout-like projection at the hyponomic sinus is located relatively farther up

along the ventral outline of the chamber, and the strongly contracted portion of the linear part of the hyponomic sinus slopes less strongly downward in a ventrad direction.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype, cat. no. 92807, U. S. National Museum.

52. *Hexameroceras schucherti* new species

*Plate XIX, figs. 1A, B*

Specimen 120 mm. long, of which length 63 mm. is occupied by the living chamber. The conch is erect. Its dorsal outline has a radius of convexity of 140 mm. from its base to 33 mm. above the base of the living chamber, above which it changes to a radius of 40 mm. as far as the aperture. Its ventral outline is nearly straight from its base as far as 20 mm. above the base of the living chamber, above which it curves inward with a radius of convex curvature of 40 mm. for a length of 10 mm., as far as the base of the protuberant spout formed by the hyponomic sinus. The latter projects forward for a distance of 5 mm. The lateral outlines of the conch present a radius of convex curvature of about 150 mm. to a point about 18 mm. above the base of the living chamber, above which they converge with a radius of 60 mm. as far as the lateral lobes of the aperture. At the base of the specimen its dorsoventral diameter is estimated at 30 mm. and its lateral one at 26 mm. At the base of the living chamber the corresponding diameters are 67 mm. and 59 mm. Its maximum dorsoventral diameter, 75 mm., is near mid-height of the living chamber. Its maximum lateral diameter, 62 mm., is about 15 mm. above the base of this chamber. The maximum length of the aperture in a dorsoventral direction is 66 mm. Its maximum width at the posterior pair of lateral lobes is 23 mm. The reentrant angle between these lobes is 5 mm. in depth. It is estimated that the width of the aperture at its middle pair of lateral lobes is 20 mm., and at its anterior pair about 13 mm. However, the narrowly contracted part of the aperture appears to widen in a dorsad direction so that only the posterior and middle pairs of lobes are conspicuous, and the anterior pair are insignificant. The average height of the camerae is 6.7 mm., except at the top

of the phragmacone, where one or two are considerably shorter, the lower one being 4 mm. long, and apparently an overlying one being still shorter. The slope of the sutures of the septa in a ventrad direction is approximately 5 degrees with the horizontal. These sutures are approximately at right angles to the ventral outline.

Occurrence: Anse-à-la-Barbe, Port Daniel; either from the Gascons or the Bouleaux formation. Holotype; cat. no. 12752, Peabody Museum, Yale University. Named in honor of Prof. Charles Schuchert.

Remarks.—That species of *Tetrameroceras* described by Blake under the name *Gomphoceras obovatum* presents a similar erect appearance and dorsoventral outline, but the sutures of the septa of the Anse-à-la-Barbe specimen slope more distinctly downward in a ventrad direction.

Among the species of *Tetrameroceras* described by Barrande, those described under the names *Phragmoceras problematicum*, *Phragmoceras vetus*, and *Phragmoceras infaustum* present similar erect forms. (Système silurien du centre de la Bohême, vol. 2, pls. 54, 55, 1865).

53. *Hexameroceras* (?) *occlusum* new species

Plate XX, figs. 2A, B

Specimen consisting only of a living chamber, the general convexity of whose upper surface rises only 42 mm. above the suture at its base, though the highest part of the margin of its aperture attains a level of 45 mm. At the suture mentioned, its dorsoventral diameter is 54 mm. and its lateral one is estimated at 42 mm. The corresponding diameters at mid-height of the chamber are 61 mm. and 46 mm. The present length of the aperture in a dorsoventral direction is 45 mm., to which should be added the unknown length of the protuberant spout formed by the hyponomic sinus, now broken off. At the posterior pair of dorsal lobes the width of the aperture is 24 mm., the depth of the reentrant angle being 9 mm. At the middle pair of lobes the width of the aperture is estimated at 20 mm. It is not known whether there ever was a third pair of lobes, anterior to those here



called middle, as in *Hexameroceras schucherti*, this part of the conch being broken off. The suture of the septum at its base is straight. The concavity of this septum is 10 mm. The passage of the siphuncle through the septum is 5 mm. long and 3.5 mm. wide, the conch evidently having been compressed by pressure after the death of the animal. The center of the siphuncle is 10 mm. from the ventral wall of the conch. The surface of the specimen is obscurely striated transversely, these striae curving downward ventrally.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 12749, Peabody Museum, Yale University.

Remarks.—In the general outline of its living chamber and of its aperture this specimen resembles *Tetrameroceras problematicum* Barrande (Système Silurien du centre de la Bohême, vol. 2, pl. 54, figs. 10–12, 1865), but the crest at the dorsal end of the aperture enters between its dorsolateral lobes more broadly, and these lobes project more directly backward. Among the species described from Great Britain by Blake it resembles most nearly the species of *Tetrameroceras* described by him as *Gomphoceras obovatum*. In the latter, however, the two pairs of lateral lobes are oriented more directly at right angles to the dorsoventral plane of the conch.

It is evident that it can not be determined from the single specimen at hand whether the species here described as *Hexameroceras occlusum* belongs to the group of species with 3 pairs of lateral lobes (*Hexameroceras*) or to the group with only 2 pairs (*Tetrameroceras*). This can be determined only from better preserved specimens. However, those parts of the aperture which are preserved show considerable resemblance to the species described here as *Hexameroceras schucherti*.

#### 54. *Phragmoceras altum* new species

Plate XX, fig. 3

Specimen 128 mm. long, consisting of a living chamber to which two camerae still are attached, but are poorly delineated. The dorsal outline of the specimen has a radius of convex curvature of

100 mm. for a length of 90 mm., and then reverses to faintly concave for an additional length of 10 mm., the dorsal margin of the aperture not being preserved. However, this reversal of curvature along the upper part of the dorsal outline of the living chamber is sufficient to indicate the relationship of this specimen to the genus *Phragmoceras*. The ventral outline of the specimen is slightly concave, except at the base of the spout-like projection formed by the hyponomic sinus, where a radius of concave curvature of 10 mm. appears to have been reached. The narrowly contracted part of the aperture slopes downward in a ventrad direction at an angle of 35 degrees with the horizontal. The margins of the dorsal expansion of the aperture are not preserved. Nothing is known of this expansion beyond the fact that it was small and was located far back, in contact with top of the dorsal outline of the living chamber, which here projects slightly posteriorly, owing to the reversed curvature at its top. The dorsoventral diameter of the specimen enlarges from 68 mm. at the base of the living chamber to 87 mm. at the base of the spout-like projection of the aperture at its hyponomic sinus. The corresponding lateral diameters are 49 mm. and 61 mm. Plate XX, fig. 3.

Occurrence: Anse-à-la-Barbe, Port Daniel; from the Gascons formation. Holotype; cat. no. 12744, Peabody Museum, Yale University.

Another specimen from the Gascons formation at the same locality has a length of 140 mm., 105 mm. of this length apparently belonging to the living chamber. At the base of this chamber its dorsoventral diameter is about 70 mm., increasing to 102 mm. at its top. Its maximum lateral diameter, a little above midlength of the chamber, is 45 mm. The radius of curvature of its dorsal outline is 140 mm., except within 5 mm. of the top of this outline, as far as preserved, where it reverses to slightly concave. Paratype, U. S. National Museum, cat. no. 92808.

#### 55. *Phragmoceras northropi* new species

*Plate XXI, fig. 2*

Specimen 80 mm. long in direct measurement, but fully 100 mm. in length when measured along its dorsal outline. The

radius of curvature of this convex dorsal outline is 45 mm. That of the concave ventral outline is 20 mm. along the living chamber, the ventral outline of the phragmacone not being preserved. The dorsoventral diameter of the living chamber enlarges from 40 mm. at its base to 48 mm. at the base of the spout-like projection formed by the hyponomic sinus. The corresponding lateral diameters are 21 mm. and 26 mm. The maximum length of the living chamber above the lowest part of the suture of the septum at its base is 41 mm. The narrowly constricted part of the aperture slopes downward in a ventrad direction at an angle of 25 degrees with the horizontal. This contracted part of the aperture is narrowest about 35 mm. from the dorsal outline of the conch and increases gradually in width in a dorsad direction as though the dorsal expansion of the aperture had a narrowly ovate outline. At the dorsolateral margin of this expansion its edge flares outward for a width of at least 2 mm. This outward flaring probably was confined to the posterior margin of the dorsal expansion of the aperture, but nothing more definite can be determined from the single specimen at hand.

Occurrence: Just west of Anse-à-la-Barbe, Port Daniel, along the fish-path leading to the shore, below the quarry; either from the Gascons or the Bouleaux formation. Holotype; cat. no. 12739, Peabody Museum, Yale University. Named in honor of Prof. Stuart A. Northrop.

Remarks.—Possibly the abrupt flaring of the posterior margin of the aperture of *Phragmoceras northropi* is similar to that of *Phragmoceras lineare* Newell, originally described under the generic name *Gomphoceras*. However, this can not be determined until better preserved specimens of the latter are discovered. There is no evidence of any thickening of the interior of the shell of the Canadian specimen into a narrow ridge or platform as in typical *Tubiferoceras* Hedström.

#### ADDENDA

##### *A. Correction of description of plates in paper on Maquoketa cephalopods*

In the paper on The Cephalopods of the Maquoketa shale of Iowa, by Aug. F. Foerste, published in the Denison Univ. Bull.,

Jour. Sci. Labs., 30, 231-257, the following figures are magnified to 3 times the diameter of the original specimens: pl. 27, figs. 2, 3, *Spyroceras clermontense*; plate 28, figs. 2, 3, *Kionoceras postvillense*; plate 29, fig. 2, *Kionoceras tenuitectum*; fig. 3 on same plate, *Polygrammoceras* sp.; fig. 4 on same plate, *Kionoceras thomasi*; and fig. 5 on same plate, *Kionoceras postvillense*.

*B. EOCRYPTAULINA; new Generic name for Gasteropod*

In 1893 Foerste<sup>5</sup> described a gasteropod from the Brassfield formation of southwestern Ohio under the name *Pleurotomaria filitexta*. In 1923, he used this species as the genotype of a new genus which he called *Cryptaulus*.<sup>6</sup> However, this name was preoccupied, having been used already in 1903 by A. Bavay<sup>7</sup> for a genus of terrestrial gasteropods. Recognizing this fact, J. R. de B. Tomlin,<sup>8</sup> in 1929, proposed the generic name *Foersteria*. Unfortunately, this name also was preoccupied, having been used by Gyötö Szepligeti<sup>9</sup> in 1896 for a genus of Braconidae, among the Hymenoptera. Hence the name *Eocryptaulina* here is proposed, *Pleurotomaria filitexta* Foerste being the genotype.

*C. PARAENDOCERAS Ulrich and Foerste*

The name *Paraendoceras* is proposed in place of *Saffordoceras* Ulrich and Foerste (1935), the latter being preoccupied by *Saffordoceras* Foerste and Teichert (1930). See Denison, Univ. Bull., vol. 25, 264 (1930) and vol. 30, 285 (1935).

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- (1) Geol. Surv. Canada, Rept. Progress for 1844, 53-54 (1846).
- (2) Geol. Surv. Canada, Geology of Canada, 443-444 (1863).
- (3) Geol. Surv. Canada, Bull. no. 44, 35-58 (1926).
- (4) Foerste, Aug. F. Denison Univ. Bull., Jour. Sci. Labs., 25, 44, pl. 6, figs. 2 A, B (1930).
- (5) Foerste, Aug. F. Geol. Surv. Ohio, Geology, vol. 7, 550, pl. 37 A, figs. 6a, b (1893).
- (6) Foerste, Aug. F. Denison Univ. Bull., Jour. Sci. Labs., 20, 95 (1923).
- (7) Bavay, A. Bull. Soc. zool. France, 28, 141 (1903). No genotype specified.
- (8) Tomlin, J. R. de B. Proc. Malacol. Soc. London, 18, 255 (1929).
- (9) Szepligeti, Gyötö. Wiener Ent. Zeitung, 15, 148 (1896).

**PLATES**

PLATE IV

- Fig. 1. *Geisonocerina barbensis* Foerste. Living chamber. Anse-à-la-Barbe, Port Daniel; from either the Gascons or Bouleaux formation. One of two cotypes; National Museum of Canada, cat. no. 6805.
- Fig. 2. *Geisonocerina barbensis* Foerste. Part of living chamber with two camerae attached. Anse-à-la-Barbe, Port Daniel; from either the Gascons or Bouleaux formation. Other of two cotypes; Peabody Museum, Yale University, cat. no. 12751.





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2

SILURIAN CEPHALOPODS OF GASPE PENINSULA

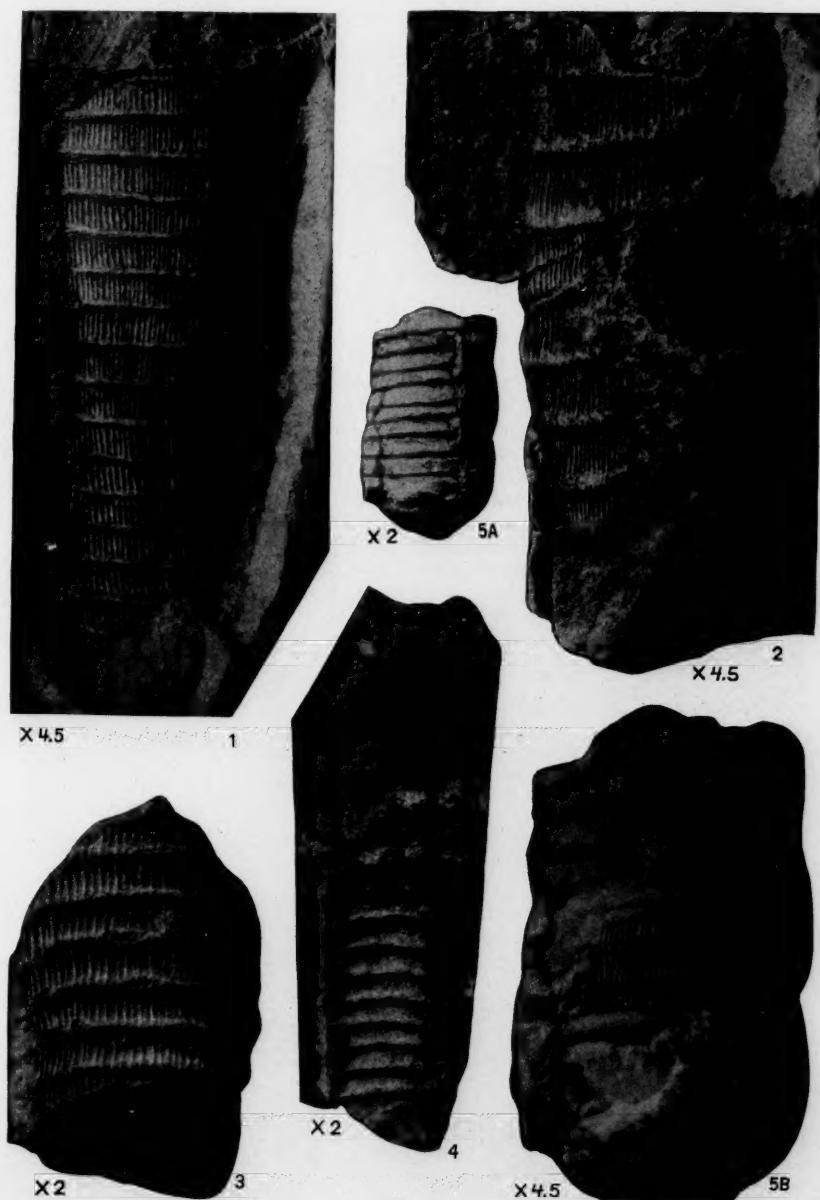
PLATE V

- Fig. 1. *Geisonocerina* (?) *danielensis* Foerste. Phragmacone only, contracted at top. Middle branch of Port Daniel river; from the Mictaw shales of Ordovician age. Holotype; Peabody Museum, Yale University, cat. no. 12775.
- Fig. 2. *Orthoceras chaleurense* Foerste. Living chamber with camerae attached. Anse-à-la-Barbe, Port Daniel; from either the Gascons or Bouleaux formation. Holotype; National Museum of Canada, cat. no. 6804.
- Fig. 3. *Geisonocerina* (?) *barbensis* Foerste. Conch preserving transverse bands on surface of shell but no trace of the septa. From highest point reached on Little Port Daniel river, in range VIII Port Daniel or probably in Hoptown, in province of Quebec. Peabody Museum, cat. no. 12715.



PLATE VI

- Fig. 1. *Spyroceras northropi* Foerste. Fragment enlarged 4.5 diameters. From the shore at Indian Point, Port Daniel; in the Indian Point formation. Holotype; Peabody Museum, Yale University, cat. no. 12772.
- Fig. 2. *Spyroceras orientale* Foerste. Fragment enlarged 4.5 diameters. From Indian Point, Port Daniel; in the Indian Point formation. Holotype; National Museum of Canada, cat. no. 6807. See also plate XIII, fig. 3.
- Fig. 3. *Spyroceras* sp. (Morrin). Fragment enlarged 2 diameters. Morrin road, Gascons, Port Daniel; in the Gascons formation. Peabody Museum, cat. no. 12717.
- Fig. 4. *Spyroceras* sp. (Clemville). Fragment enlarged 2 diameters. From a road-cut at the old lime-kiln, near Clemville, Port Daniel; in the Clemville formation. Peabody Museum, cat. no. 12701.
- Fig. 5. *Spyroceras chaleurense* Foerste. A, a fragment enlarged 2 diameters; B, same, enlarged 4.5 diameters. Reddish Point ridge, Gascons, Port Daniel; in the West Point formation. Holotype; Peabody Museum, cat. no. 12761.



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PLATE VII

- Fig. 1. *Protokionoceras microlineatum* Foerste. Fragment showing sutures of two septa. From the shore at Indian Point; in the upper portion of the Indian Point formation. Holotype; Peabody Museum, Yale University; cat. no. 12768A.
- Fig. 2. *Protokionoceras* cf. *microlineatum* Foerste. Fragment from a larger conch, from the same locality and horizon as the preceding. Peabody Museum, cat. no. 12768B.
- Fig. 3. *Protokionoceras* cf. *microlineatum* Foerste. Fragment from a larger conch, from the same locality and horizon as the two preceding. National Museum of Canada, cat. no. 6806.
- Fig. 4. *Kionoceras bouleauxense* Foerste. Lateral view, including part of living chamber and two camerae. From Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. One of two cotypes; Peabody Museum, cat. no. 12733.
- Fig. 5. *Kionoceras bouleauxense* Foerste. Base of living chamber with five camerae still attached. Same locality and horizon as the preceding. Other one of two cotypes; Peabody Museum, cat. no. 12731.
- Fig. 6. *Kionoceras* sp. (Bouleaux). Living chamber with one camera still attached; with vertical ribs subequal in prominence. From Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Peabody Museum, cat. no. 12728.





PLATE VIII

- Fig. 1. *Protokionoceras imperator* Foerste. Lower end of lateral side of the holotype, reduced to 0.8 of original diameter, showing vertical ribs and striae on surface of one of its sides. Including all of phragmacone except upper 4 camerae. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype, National Museum of Canada, cat. no. 6818.
- Fig. 2. *Protokionoceras imperator* Foerste. Same specimen as the preceding; ventral side, but reduced to 0.43 of its original diameter in order to include all of the phragmacone and most of the living chamber. The base of the living chamber is at *A*, its maximum lateral diameter is reached at *B*, and its top is at least 100 mm. above *B*. See also plate IX, fig. 1.



#### PLATE IX

- Fig. 1. *Protokionoceras imperator* Foerste. Lower end of the dorsal side of the holotype, reduced to 0.85 of its original diameter, showing relative number of camerae in a length equal to the lateral diameter of the conch. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 6818. See also plate VIII, figs. 1, 2.
- Fig. 2. *Huronina gaspensis* Foerste. Vertical section through siphuncle at angle of 45 degrees to dorsoventral plane of symmetry, with ventral outline on left. Reduced to 0.85 of its original diameter. Behind Le Grande hotel, Port Daniel, in the La Vieille formation. Holotype; U. S. National Museum, cat. no. 92804.
- Fig. 3. *Dawsonoceras* sp. From midlength of a specimen 330 mm. long, enlarging near middle from diameter of 43 mm. to 55 mm. in a length of 200 mm. Reduced to 0.85 of its original diameter. Near mouth of Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. U. S. National Museum, cat. no. 92793.



X0.85

2



X0.85

3



X0.85

1

# PLATE X

- Fig. 1. *Cycloceras* (?) *gaspense* Foerste. Lateral view with ventral outline on left. Only the phragmacone is preserved, contracted along the upper two camerae. From the shore at Indian Point, Port Daniel; in the Indian Point formation. Holotype; Peabody Museum, Yale University, cat. no. 12766.
- Fig. 2. *Geisonoceras* sp. (Indian Point). Apparently the lower part of the living chamber, showing the transverse banding on the surface of the shell. From the shore at Indian Point, Port Daniel; in the upper part of the Indian Point formation. Peabody Museum, cat. no. 12769.
- Fig. 3. *Rizoceras dartae* Foerste. Lateral view with ventral outline on right. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 6809.
- Fig. 4. *Cyrtorizoceras tarbense* Foerste. Lateral view with ventral outline on left, the living chamber constricted slightly near its upper end by an annular thickening of its interior which leaves a broad, shallow groove on the cast of this interior, as figured here. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 6810.
- Fig. 5. *Geisonoceras* (?) sp. (Anse-à-la-Barbe). Part of a phragmacone, with the outer margin of a septum at its base. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Peabody Museum, cat. no. 12746.
- Fig. 6. *Rizoceras atlanticum* Foerste. Apparently part of a living chamber, with its ventral outline on the left, rounded at its base in an anomalous manner. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype: Peabody Museum, cat. no. 12741.





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PLATE XI

- Fig. 1. *Cyrtorizoceras schucherti* Foerste. A, lateral view, with ventral outline on left; B, ventral view showing downward curvature of transverse bands at former locations of the hyponomic sinus, also slight angularity of median part of ventral saddles of septa. Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, Yale University, cat no. 12748.
- Fig. 2. *Cyrtorizoceras* sp. (Bouleaux). Part of a living chamber with several camerae still attached; with ventral outline indicated at base on right. From Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Peabody Museum, cat. no. 12732.
- Fig. 3. *Perioidanoceras* (?) *chaleureuse* Foerste. Dorsoventral section exposing the siphuncle, with ventral outline on right. From the shore at Indian Point, Port Daniel; in the Indian Point formation. Holotype: Peabody Museum, cat. no. 12774.

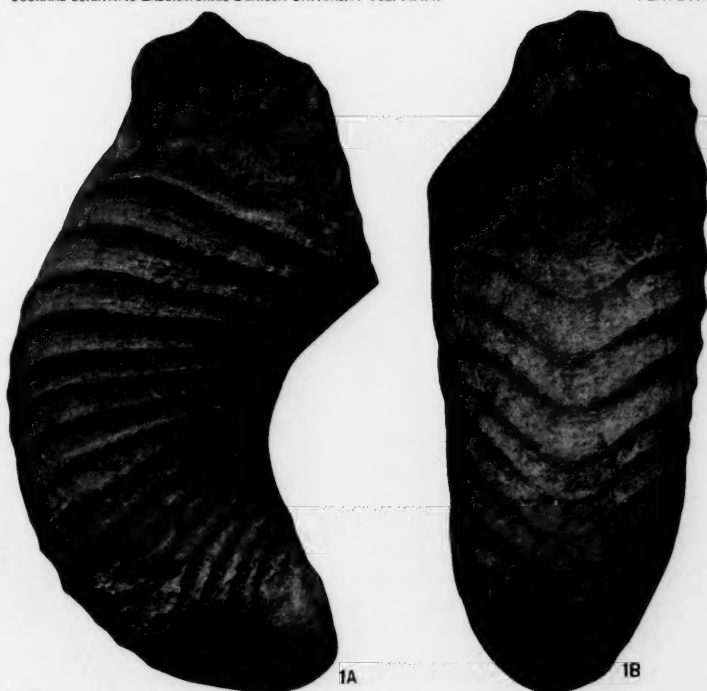


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PLATE XII

- Fig. 1. *Gasconsoceras obesum* Foerste. A, lateral view with ventral outline on left, showing some of the transverse striae near its upper end; B, ventral view, showing a narrower downward curvature of the transverse annulations or ribs than in *Gasconsoceras pulchellum*. Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, Yale University, cat. no. 12745.
- Fig. 2. *Gasconsoceras cascapediense* Foerste. Lateral view of last volution with ventral outline on convex margin; showing the sutures of the septa along the upper part of the phragmacone. From the Black Capes, near Little Cascapedia River, 45 miles west of the Port Daniel area; in the middle part of the Gascons formation. Holotype; Peabody Museum, cat. no. 12723.



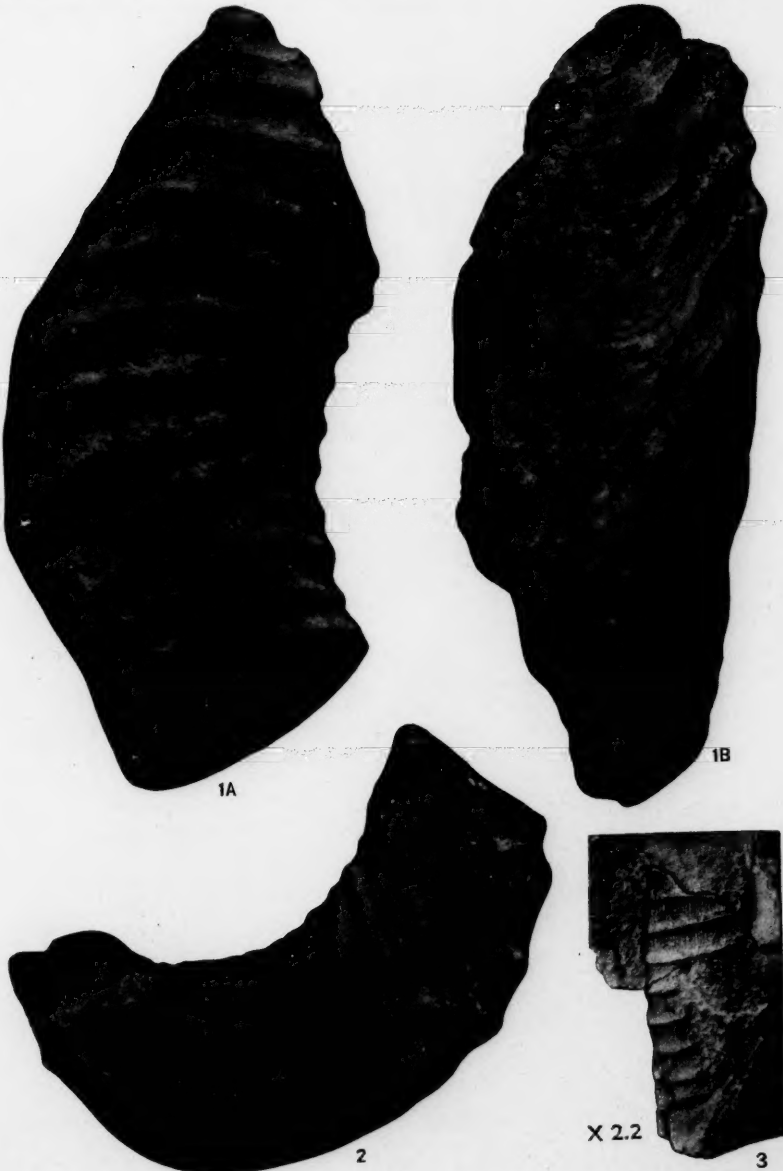
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PLATE XIII

- Fig. 1. *Gasconsoceras* cf. *planiventrum* Foerste. A, lateral view, with its ventral outline on the left, the latter being much distorted; B, ventral view, showing the flattening of its ventral side, the disappearance of the transverse ribs along the median part of this side, and the broad downward curvature of the transverse ribs and striae. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Peabody Museum, Yale University; cat. no. 12750.
- Fig. 2. *Gasconsoceras pulchellum* Foerste. View laterally oblique, with its ventral outline along its convexly curved side; illuminated to show the minute longitudinal striae, and also those parts of the transverse annulations which cross the ventral side of the conch. The latter are much weaker ventrally than laterally, but here the transverse striae are much more conspicuous. Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype: Peabody Museum, cat. no. 13099.
- Fig. 3. *Spyroceras orientale* Foerste. Fragment enlarged 2.2 diameters. From Indian Point, Port Daniel; in the Indian Point formation. Holotype; National Museum of Canada, cat. no. 6807. See also plate VI, fig. 2.





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PLATE XIV

- Fig. 1. *Bickmorites* cf. *barbensis* Foerste. Lateral view with ventral outline on right. From Anse-à-la-Barbe; either from the Gascons or the Bouleaux formation. Paratype; National Museum of Canada, cat. no. 6812.
- Fig. 2. *Bickmorites barbensis* Foerste. Lateral view, with ventral outline on right. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Paratype; National Museum of Canada, cat. no. 6814. See also plate XV, figs. 1A, B; plate XXVI, fig. 1.



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PLATE XV

- Fig. 1. *Bickmoriles barbensis* Foerste. A, lateral view, with ventral outline on left; B, ventral view, with left side weathered away, showing disappearance of transverse ribs and the broad downward curvature of the transverse ribs and striae on the median part of this side. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Paratype; National Museum of Canada, cat. no. 6815. See also plate XIV, fig. 2; plate XXVI, fig. 1.
- Fig. 2. *Gasconsoceras* cf. *obesum* Foerste. Lateral view, with ventral outline on convex side. From Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Peabody Museum, Yale University, cat. no. 12729.



1A



1B



2

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PLATE XVI

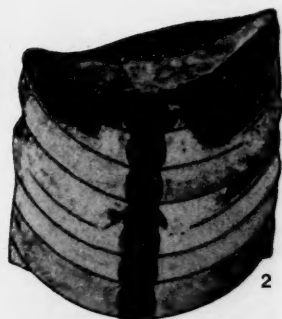
- Fig. 1. *Bickmorites americanus* (Billings). Lateral view, showing base of living chamber below its middle on the left; upper part of living chamber showing its gerontic stage, the annulations replaced by transverse bands. From Anse-à-la-Barbe, 3 miles east of Port Daniel; from the Gascons formation. Holotype; National Museum of Canada, cat. no. 6813.
- Fig. 2. *Amphicyrtoceras cooperi* Foerste. A, ventral view, showing both the surface striae and the sutures of the septa; B, lateral view, showing the location of one of the segments of the siphuncle at its base. From the railroad cut above Vieille, Gascons; in the La Vieille formation. Holotype; Peabody Museum, Yale University, cat. no. 13148.





PLATE XVII

- Fig. 1. *Orthoceras clemvillense* Foerste. A, ventral view, with a trace of the siphuncle at its base; B, dorsoventral section of the lower half of the same, with its ventral outline on the right; also exposing the siphuncle. From Clemville, near Port Daniel; in the Clemville formation. Holotype; Peabody Museum, Yale University, cat. no. 12704.
- Fig. 2. *Orthoceras clemvillense* Foerste. Apparently a lateral section, exposing the siphuncle. From Little Port Daniel River; in the Hyattidina zone of the Clemville formation. Paratype; Peabody Museum, cat. no. 12705.
- Fig. 3. *Ormoceras* sp. (West Point). A, fragment showing the structure of the siphuncle; B, another fragment from the lower part of the same specimen, showing its rate of enlargement and the relative number of camerae in a width which is slightly less than the total width of the complete conch. From along the shore between West Point and Indian Point; in the West Point formation. Peabody Museum, cat. no. 12753.



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PLATE XVIII

- Fig. 1. *Armenoceras wellsae* Foerste. A, ventral view, with vertical striae on the surface of the shell; also showing faint traces of camerae; B, dorsoventral section of the same, with ventral outline on the right. From one and a half miles east of Gascons, in the railroad cut; in the La Vieille formation. Holotype; Peabody Museum, Yale University, cat. no. 12710.
- Fig. 2. *Dartoceras nodosum* Foerste. Lateral view, with ventral outline on the convex side, showing nodes along its ventrolateral parts and downward deflections of the transverse ribs near the dorsolateral parts of the conch. From the west side of McInnis Cove, at the northern end of Port Daniel Bay; in the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 6811.
- Fig. 3. *Calocyrtoceras bouleauxense* Foerste. Lateral view, with ventral outline on convex side. From Pointe-aux-Bouleaux, Gascons; in the Bouleaux formation. Holotype; Peabody Museum, cat. no. 12727.



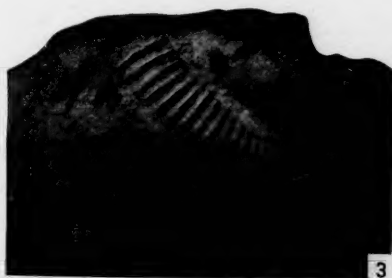
1A



1B



2



3

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PLATE XIX

- Fig. 1. *Hexamerocheras schucherti* Foerste. A, viewed from above, with ventral side on left, to show the dorsal lobes of the aperture. Three of these lobes are indicated along the upper margin of the aperture as here oriented, and there is a trace also of the incurving crest of the dorsal margin of this aperture, between the two posterolateral lobes on the shadowed side of the figure. B, lateral view, with ventral outline on right, showing three lateral lobes at the dorsal end of the aperture; also the spout-like projection at the hyponomic sinus. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, Yale University, cat. no. 12752.
- Fig. 2. *Spyrocheras danielense* Foerste. A, fragment magnified 2 diameters; B, same, magnified 4.5 diameters to show the vertical and transverse striae. Indian Point, Port Daniel; in the Indian Point formation. Holotype; National Museum of Canada, cat. no. 6808.





1A



X 2

2A



1B

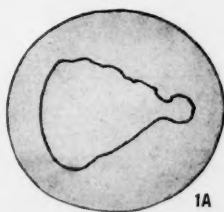


X 4.5

2B

PLATE XX

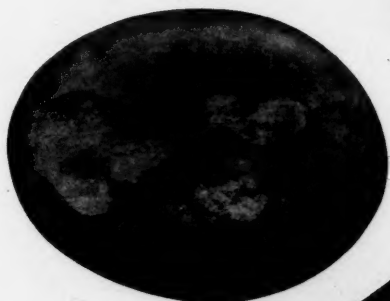
- Fig. 1. *Mandaloceras erectum* Foerste. A, diagram of top of specimen showing aperture in its present state; B, lateral view, with ventral outline on right. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, Yale University, cat. no. 12743.
- Fig. 2. *Hexameroceras* (?) *occlusum* Foerste. A, lateral view, showing one postero-lateral and one lateral lobe along the dorsal expansion of the aperture; also the base of the spout-like projection at the hyponomic sinus; B, viewed from above, to show such lobes at the dorsal end of the aperture as are preserved. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, cat. no. 12749.
- Fig. 3. *Phragmoceras altum* Foerste. A, lateral view, with ventral outline on left, and with two camerae poorly indicated at its base. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, cat. no. 12744.



1A



2A



2B



1B



3

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PLATE XXI

- Fig. 1. *Hexameroceras inflatum* Foerste. A, lateral view with ventral outline on right, showing the three lateral lobes on the right side of the aperture and the location of the base of the spout-like projection at its hyponomic sinus; B, ventral side, showing the hyponomic sinus of the aperture; C, obliquely dorsal view to show the protuberance posterior to the dorsal margin of the aperture, interpreted by Hyatt as a seventh or azygous lobe of the latter; D, same, viewed directly from above; E, another view from above but oriented so as to throw the right side of the aperture into the light. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 6817.
- Fig. 2. *Phragmoceras northropi* Foerste. Lateral view, with ventral outline on left, showing the outward flaring of the margin of the aperture dorso-laterally. This flaring is assumed to continue also dorsally. From just west of Anse-à-la-Barbe, Port Daniel, along the fish-path leading to the shore, below the quarry; from either the Gascons or the Bouleaux formation. Holotype; Peabody Museum, Yale University, cat. no. 12739.



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PLATE XXII

Fig. 1. *Mandaloceras subgracile* (Billings). A, ventral view; B, lateral view, with ventral outline on left; C, viewed from above, with ventral part of aperture directed upward, showing the left dorsal lobe and the forward curving crest of the dorsal margin of this aperture; D, reconstruction of the specimen as viewed from above, with aperture oriented as in figure C; E, reconstruction of upper part of specimen, with ventral outline on left, oriented as in figure B; F, reconstruction of ventral side of specimen, showing hyponomic sinus, oriented as in figure AA. From Anse-à-la-Barbe, Port Daniel; from either the Gascons or the Bouleaux formation. Holotype; National Museum of Canada, cat. no. 3053.

Fig. 2. *Armenoceras gasconsense* Foerste. A, ventral view, showing downward curvature of sutures of the septa; B, dorsoventral section of same, with ventral outline on right, showing structure of the siphuncle. From one and a half miles east of Gascons, in the La Vieille formation. Holotype; National Museum of Canada, cat. no. 6816.



1A



1B



1C



1D



1E



1F



2A



2B



PLATE XXIII

- Fig. 1. *Protokionoceras perstrigatum* Foerste. Showing vertical ribbing and indications of three camerae at its base. Near mouth of Anse-à-la-Barbe River, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92790.
- Fig. 2. *Spyroceras* sp. (Anse-à-la-Barbe). View showing rate of enlargement of conch and prominence of annulations. Near mouth of Anse-à-la-Barbe River, Port Daniel; in the Gascons formation. U. S. National Museum, cat. no. 92792.
- Fig. 3. *Rizoceras infundibuliforme* Foerste. Number of camerae uncertain, but exposing one deeply concave septum. Near mouth of Anse-à-la-Barbe River, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92795.
- Fig. 4. *Rizoceras pocilliforme* Foerste. Conch apparently with rounded base, showing camerae and also the transverse striae on the surface of both the living chamber and the camerae. Near mouth of Anse-à-la-Barbe River, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92794.
- Fig. 5. *Spyroceras barbense* Foerste. Living chamber with three camerae at its base. Near mouth of Anse-à-la-Barbe River, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92791.
- Fig. 6. *Spyroceras barbense* Foerste. Rate of enlargement of lower half of conch apparently is larger than farther up. Near mouth of Anse-à-la-Barbe River, Port Daniel; in the Gascons formation. Paratype; U. S. National Museum, cat. no. 92791A.



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# PLATE XXIV

- Fig. 1. *Hexameroceras erectum* Foerste. Lateral view showing spout-like projection at hyponomic sinus; also the anterior and middle lateral lobes on the dorsal part of the aperture, the posterior lateral lobe not being preserved on this side of the living chamber. Near the mouth of the Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92807.
- Fig. 2. *Hexameroceras erectum* Foerste. View of top of preceding specimen. The latter is distorted obliquely but shows trace of left posterolateral lobe of aperture; also azygous hump in spaces between the two posterolateral lobes.
- Fig. 3. *Mandaloceras subgracile* (Billings). Ventral view of conch with siphuncle about half way between center and ventral wall; also with trace of hyponomic sinus directed obliquely forward and slightly toward the right. Near the mouth of the Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. U. S. National Museum, cat. no. 92806B.
- Fig. 4. *Mandaloceras subgracile* (Billings). Orientation uncertain, but apparently the siphuncle is located close to the wall of the conch on the right side of the specimen as here figured, suggesting that the right outline is ventral. Location and horizon as in preceding specimen. U. S. National Museum, cat. no. 92806C. See also plate XXVI, fig. 2.
- Fig. 5. *Mandaloceras subgracile* (Billings). Lateral view, with siphuncle located close to the wall of the conch on the right side of the specimen as here figured, indicating that the right outline is ventral. Conch apparently distorted least by compression among those known at present. Location and horizon as in the preceding two specimens. U. S. National Museum, cat. no. 92806A.
- Fig. 6. *Cyrtorizoceras gasconsense* Foerste. Lateral view with ventral outline on left, with traces of camerae in lower half. Reddish Point, near Gascons village, Port Daniel area; in the West Point formation. Holotype; U. S. National Museum, cat. no. 92797.
- Fig. 7. *Gaspocyrtoceras telleri* Foerste. Lateral view with suture at base of living chamber crossing an annulation in a sinuous direction. From Milwaukee, Wisconsin; in the Racine formation. Holotype; U. S. National Museum, cat. no. 92799.
- Fig. 8. *Gaspocyrtoceras telleri* Foerste. Ventral view of same specimen as the preceding, with annulations almost directly transverse to the length of the conch.
- Fig. 9. *Gaspocyrtoceras telleri* Foerste. Lateral view of a second specimen, with ventral outline on left; showing suture at base of living chamber crossing an annulation. From same locality and horizon as the preceding. Paratype; U. S. National Museum, cat. no. 92799 A.
- Fig. 10. *Gaspocyrtoceras cooperi* Foerste. Ventral view, showing downward curvature of the annulations on this side. Reddish Point, near Gascons village; Port Daniel area; in the West Point formation. Holotype; U. S. National Museum, cat. no. 92798. See also plate XXV, figs. 1, 2.
- Fig. 11. *Kionoceras barbense* Foerste. Conch distorted, causing sinuous course of the sutures of the septa. Near mouth of Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92789.

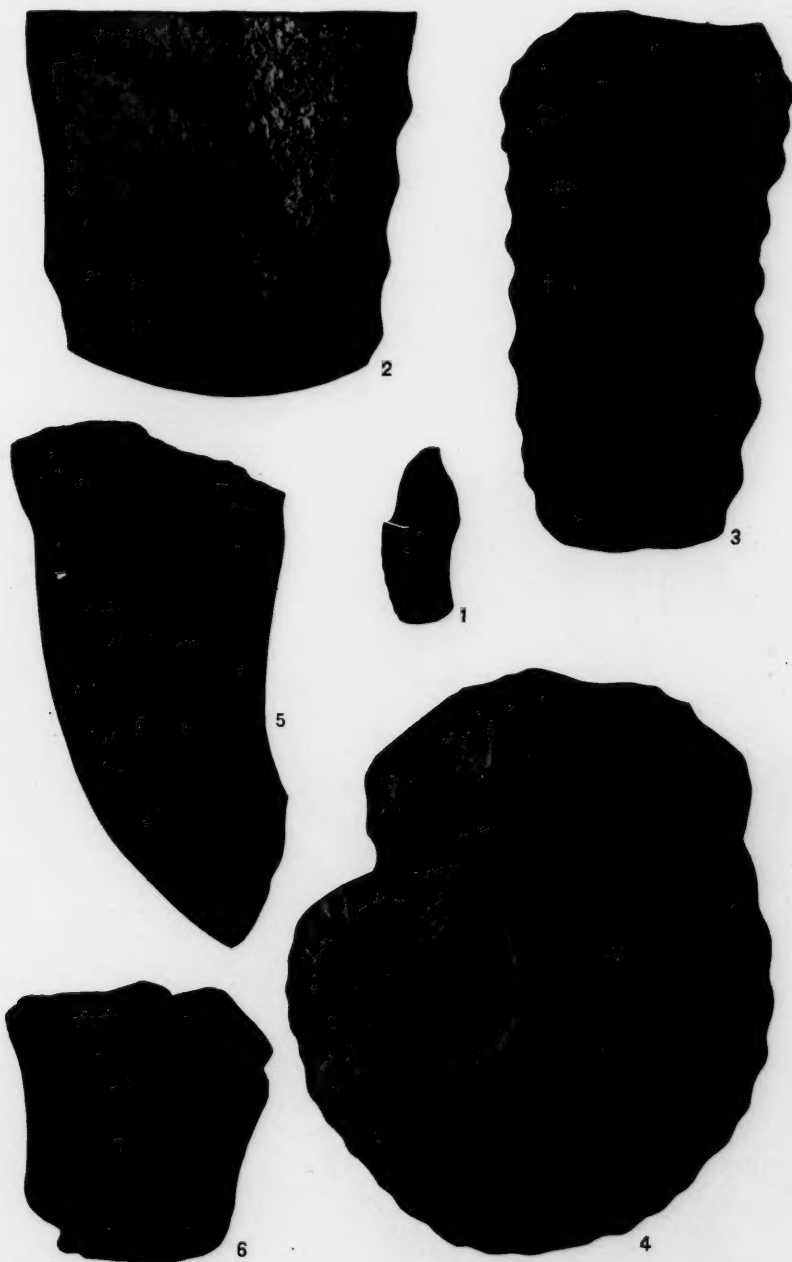


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PLATE XXV

- Fig. 1. *Gaspocyrtoceras cooperi* Foerste. Lateral view, showing downward curvature of annulations in a ventral direction. Reddish Point, near Gascons village; Port Daniel area; in the West Point formation. Holotype; U. S. National Museum, cat. no. 92798. See also plate XXIV, fig. 10.
- Fig. 2. *Gaspocyrtoceras cooperi* Foerste. Basal part of ventral side of the preceding specimen, magnified 6 diameters in order to show the minute vertical raised lines on the surface of the shell.
- Fig. 3. *Gasconsoceras planiventrum* Foerste. Ventral side, showing disappearance of transverse ribs on median part of this side, their course being continued by transverse raised lines. Near mouth of Anse-à-la-Barbe river, Port Daniel area; in the Gascons formation. Holotype; U. S. National Museum cat. no. 92800.
- Fig. 4. *Gasconsoceras obesum* Foerste. Lateral view showing the last volution of the conch, the living chamber possibly being in light contact with the preceding volution locally. Near mouth of Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. Paratype; U. S. National Museum, cat. no. 92801.
- Fig. 5. *Cyrtorizoceras diagonale* Foerste. Lateral view, with ventral outline on left. Transverse bands cross sutures of septa at a conspicuous angle. Near mouth of Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. Holotype; U. S. National Museum, cat. no. 92796.
- Fig. 6. *Cyrtorizoceras diagonale* Foerste. Lateral view, with ventral outline on right. Transverse bands as in preceding specimen. Near mouth of Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. Paratype; U. S. National Museum, cat. no. 92796 A.



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PLATE XXVI

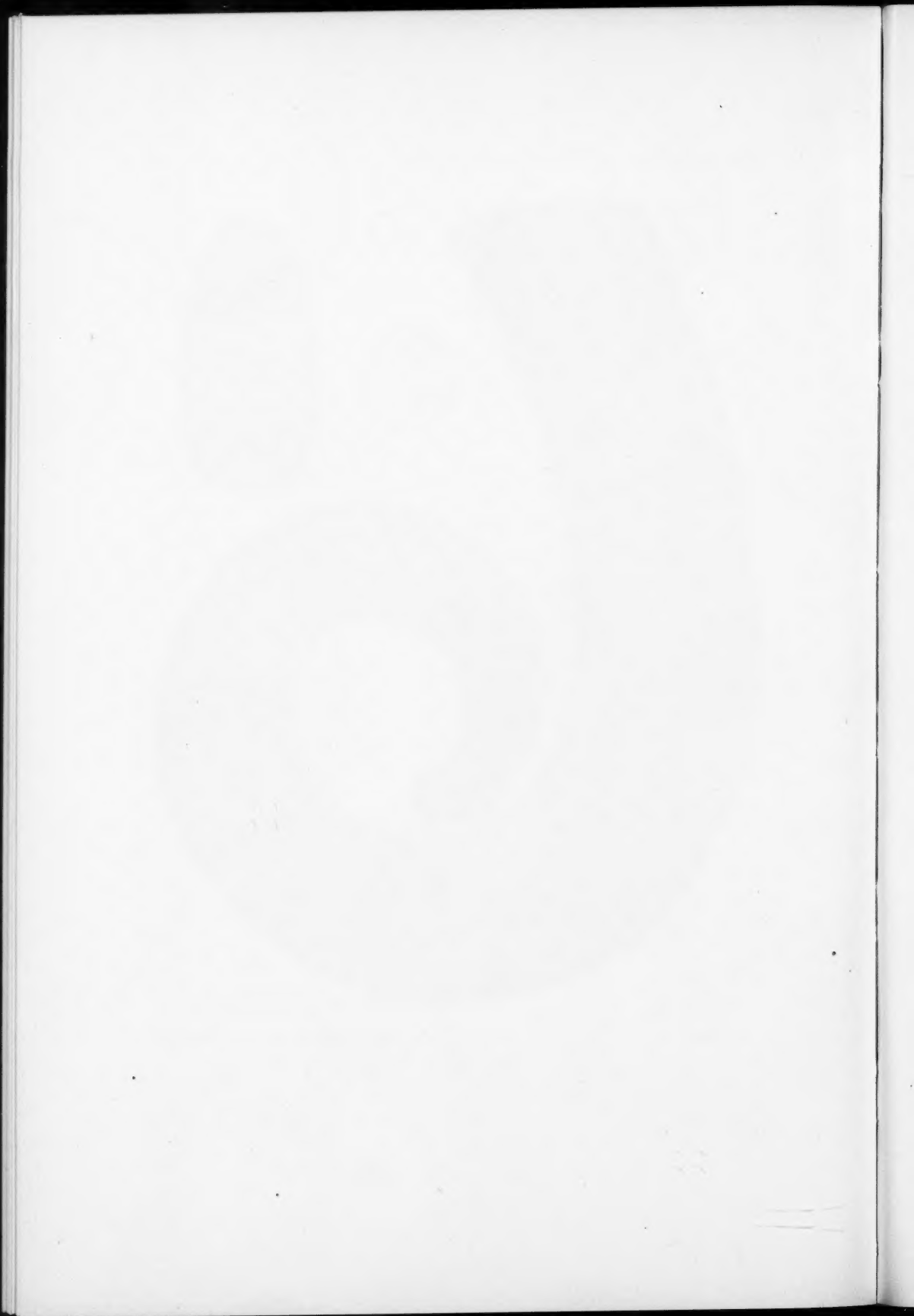
- Fig. 1. *Bickmorites barbensis* Foerste. Annulations disappearing in upper 30 mm. of the length of the living chamber. Coiling apparently gyroceratic. Anse-à-la-Barbe, Port Daniel; in the Gascons formation. Holotype; Redpath Museum, McGill University, cat. no. 2-3502. Figure reduced to four-fifths of original diameter. See also plate XIV, figs. 1, 2; plate XV, figs. 1 A, B.
- FIG. 2. *Mandaloceras subgracile* (Billings). Siphuncular side of conch. Near mouth of Anse-à-la-Barbe river, Port Daniel; in the Gascons formation. U. S. National Museum, cat. no. 92806. See also plate XXII, figs. 1 A-F and plate XXIV, figs. 3, 4, 5.
- FIG. 3. *Mandaloceras subgracile* (Billings). Cross section of same specimen, showing location of siphuncle.





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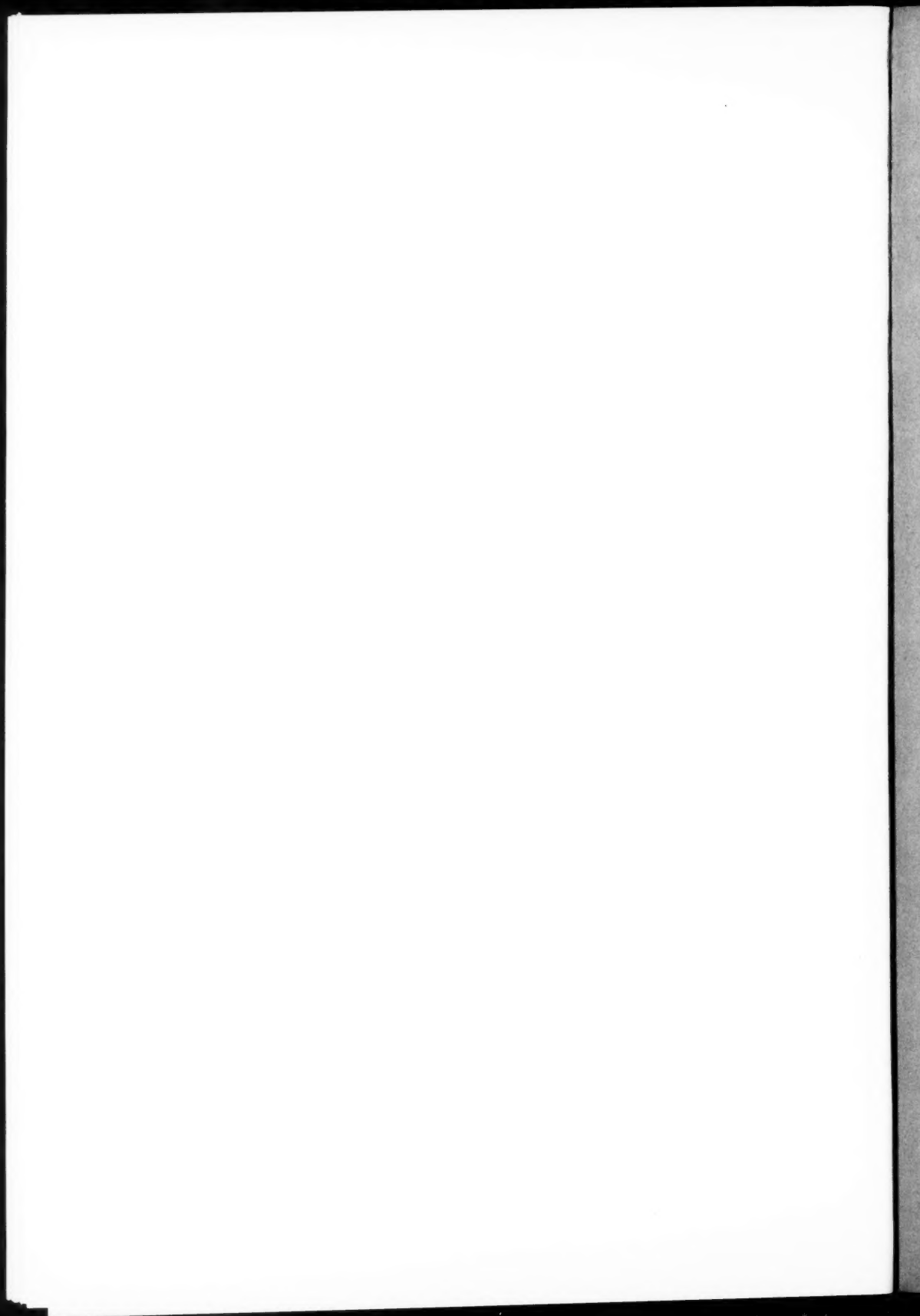
Announcement is made of the sudden death of

**DR. AUG. F. FOERSTE**

at Dayton, Ohio, April 23, 1936. Dr. Foerste's papers appeared in this JOURNAL from its initial number in 1885 until the present issue, a period of fifty-one years. An appreciation of Dr. Foerste and his work will appear in a future number of THE JOURNAL OF THE SCIENTIFIC LABORATORIES OF DENISON UNIVERSITY.

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